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AN  
INTRODUCTION  
TO  
**MINERALOGY;**  
ADAPTED TO THE USE OF SCHOOLS,  
AND PRIVATE STUDENTS.

ILLUSTRATED BY NEARLY TWO HUNDRED WOOD CUTS.

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BY JOHN L. COMSTOCK, M. D.

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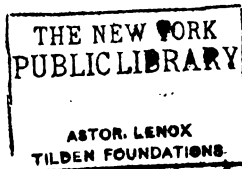
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## ADVERTISEMENT.

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The Introductory part of this volume is entirely new, and has been prepared with the intention of making the subjects of which it treats, understood with the greatest possible facility by youth and private students. More than forty new cuts have been added to this part of the work, and by means of which it is believed that any person with ordinary diligence, may understand the elements of crystallography in a few days.

In the descriptive part of the work, the synonyms have been chiefly omitted, as occupying a considerable portion of space without any adequate advantage to the beginner. The more rare varieties have also been left out for the same reason.

Corrections have been made in most parts of the volume, some of them in consequence of the kindness of scientific friends, and the whole, it is hoped, made more acceptable to the public, both in respect to accuracy and price, than the former edition.

J. L. C.

Hartford, June, 1832.



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## INTRODUCTION TO MINERALOGY.

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In the acquirement of knowledge by study, there is no greater incentive to perseverance, than a consciousness of having made progress. It is on this account that I shall at once introduce my young students to the practical study of minerals, without first incumbering their memories with a list of technical words, of which, at present, they are supposed to know nothing.

Suppose, then, that we have before us three minerals, of the names and qualities of which the pupil is entirely ignorant, and that these are *common quartz*, *common limestone*, or *carbonate of lime*, and *iron ore*. These are selected as being widely disseminated, and therefore to be found in almost every section of country.

In their appearance, the two substances first named may resemble each other, viz. in colour, form, and transparency; but in these, as well as in nearly every other respect, they both differ from all the varieties of iron ore, which are more weighty, and generally of a darker colour. The most obvious properties of quartz are a splintery fracture, a vitreous, or glassy lustre, and such a degree of hardness as to scratch glass, and give fire with steel.

Quartz is also most commonly of a light colour, and more or less transparent. Limestone has an uneven fracture, a glimmering, or shining lustre, is so soft as readily to be scratched by a knife, and never scratches glass. The lime effervesces, or seems to boil, when a drop of sulphuric acid is made to touch it; and when strongly heated, becomes opaque, and if then a little water be thrown on it, falls into fine powder, which is well known under the name of *quicklime*. On the quartz the acid has not the least effect, and when this sub-

---

What are the three minerals, the qualities of which it is here proposed to examine?—Why are these three selected?—In what respects do common quartz and limestone resemble each other?—How may limestone and quartz be distinguished from each other?

stance is heated and thrown into water, it only cracks in pieces like glass, but is not reduced to powder, like the lime.

Besides their greater weight, and darker colour, the iron ores have a lustre which is metallic, that is, like a metal, or are dull and earthy, having no lustre at all. Many kinds of iron ore are attracted by the magnet, especially when reduced to small particles. Carbonate of lime, and quartz, never possess this property. If the iron ore is not magnetic in its natural state, it becomes so after being heated on charcoal with the blowpipe (*see blowpipe*).

Thus the difference between quartz, limestone, and iron ore, is readily distinguished, and may be stated in a few words. The quartz is hard, scratches glass—cannot be scratched by a knife, is not effected by the acids, and does not burn to quicklime when heated. The lime yields to the knife, effervesces with acids, burns to quicklime, and never scratches glass. The iron ore is dark coloured, heavy, and is either magnetic, or becomes so after being heated on charcoal. Iron also strikes a black colour with powdered nutgalls, after being dissolved in diluted sulphuric acid.

Thus the learner, by means of a little acid, a magnet, and a few pieces of charcoal, or a blowpipe, can, in a few minutes, enable himself to distinguish quartz from carbonate of lime, and both these from iron ore, and will at the same time become acquainted with the leading properties of each of these substances.

There are however many varieties of each of these minerals, which differ from each other in various respects. Thus one variety of quartz may differ from another in respect to colour, fracture, lustre, transparency, and form. The varieties of carbonate of lime differ from each other, in colour, form, fracture, lustre, odour, adhesion to the tongue, hardness, and transparency; while the varieties of iron ore vary in respect to hardness, colour, lustre, form, fracture, magnetism, specific gravity and hardness. Still there are some common properties in respect to which all the varieties of each kind agree with one another. Thus, all the varieties of quartz agree in scratching glass, in being insoluble in acids, in possessing

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How does iron ore differ from the limestone and quartz?—If iron ore is not magnetic in its natural state, how does it become so?—What is the sum of the differences between quartz, limestone and iron ore?—In what respects do the varieties of quartz differ from each other?—In what respects do the varieties of lime differ from each other?—What difference is there between the varieties of iron ore?—In what do all the varieties of quartz agree?

more or less a vitreous lustre, and in being infusible by heat. The properties common to carbonate of lime, are effervescence with acids, yielding to the knife, and conversion into quicklime by heat. While the common properties of iron ore are considerable weight, fusibility by heat, and thereby becoming magnetic—a dark colour, and especially that of making a black colour with nutgalls, after solution in sulphuric acid.

Thus far it is only expected that the learner will be enabled to distinguish the several varieties of quartz, from those of carbonate of lime, or in other words the *silicious* from the *calcareous* minerals, and these, from the ores of iron.

But the inquiring pupil will soon find that there are many species of stones which are neither silicious nor calcareous, and that there is a great variety of ores besides those of iron, and which, therefore, cannot be distinguished by the tests above described. These he will learn to distinguish by methods to be described hereafter. At present we will confine ourselves to the three kinds of minerals already named, and endeavour to find the means of identifying the several varieties of each kind, or family, from one another.\*

Suppose the learner meets with a number of stones, or fragments of minerals, the names of which he does not know. He begins by ascertaining whether any of them will scratch glass, effervesce with acids, or attract the magnet. If there are crystals among them, he had better neglect these until he has gained some knowledge of the other specimens. The most common minerals should be examined first, and among these will almost every where be found those of carbonate of lime, quartz, and iron ore.

By every experiment the learner makes, he will acquire more or less knowledge, for if he ascertains only what the specimen is *not*, he takes a step towards ascertaining what it is.

The most common colours of quartz are white, yellowish white, yellow, reddish, and brown. The colours of carbonate

\* The pupil is advised to refer to the Glossary, for every technical term which he does not understand.

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What are the properties common to all the varieties of carbonate of lime?—What are the common properties of iron ore?—How does the learner begin when he wishes to ascertain unknown minerals?—Which should the learner first examine, the common or rare minerals?—What minerals will probably occur in most common collections?—Does the learner gain any knowledge by ascertaining what a mineral is *not*?—What are the most common colours of quartz?

of lime are white, greyish white, red, brown, and black. Sometimes these colours are variously mixed, forming spots, stripes, or bands, in the same specimen, as is often seen in the polished marbles, which are all of them varieties of carbonate of lime. The varieties of the two families may, however, be readily distinguished from each other, by the hardness of the quartz and the effervescence of the lime, as already described; and the iron ore will as readily be known from these, by its weight, colour, and magnetism.

If the pupil has a considerable number of specimens before him, and undertakes to learn the names of each, indiscriminately, he will soon become confused, and unless he has uncommon perseverance will grow fatigued, and discouraged. The best method, therefore, will be to select out all the minerals of certain families, or kinds, leaving the others for future examination. Thus let him select out all the specimens which scratch glass, then all those which effervesce with acids, and then all such as are magnetic, and let each kind be laid by themselves. Lastly let all the crystals, of whatever form, also have a place by themselves. Thus the pupil will have ascertained which are probably silicious minerals, which are calcarious, and which are ferruginous, or belong to ores of iron.

His next step will be to inform himself what are the species, or varieties, and consequently what the names of the specimens in each division.

#### QUARTZ.

The species, quartz, contains a considerable variety of minerals, which differ from each other in many, or most, of their external characters, and which are known under different names.

Among the specimens which possess the vitreous lustre, scratch glass, and give fire with steel, one may be white, another brown, another green, or yellow, &c. Some or many of these may be the result of crystallization, for there is no mineral more disposed to form crystals than quartz. But neglecting at present the crystalline forms, we proceed to compare our specimens with the sub-species and varieties of quartz, as hereafter described. We shall include within the range of uncrystallized quartz the varieties of chalcedony,

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What are the common colours of carbonate of lime?—What is said concerning the indiscriminate examination of a large number of minerals?—How is the learner to proceed?—What is said about the disposition of quartz to form crystals?

carnelian, flint, and hornstone, these substances having the characters of quartz, except the lustre, which is not so decidedly vitreous.

The names of the principal varieties of quartz are, *granular quartz*, *smoky quartz*, *fetid quartz*, *yellow quartz*, *brown quartz*, *limpid quartz*, *milky quartz*, *rose quartz*, *ferruginous quartz*, and *violet quartz*, or *amethyst*.

The pupil, having ascertained by the directions already given that his specimen belongs to the quartz family, has now only to compare it with the descriptions of the several varieties of that substance in order to determine its name, and leading properties. Thus if the specimen is granular, that is, composed of fine grains, of a white or greyish white colour, and massive, that is, not crystallized, it is granular quartz. If the specimen is of a yellow colour, it is yellow quartz, or citrine; if of a rose colour, it is rose quartz, &c.

Many of the varieties of quartz are found both massive, (that is, uncrystallized,) and in crystals; but there are several varieties of stones which are composed almost entirely of quartz, or silex, which always occur massive, being never found in the form of crystals. Now as minerals are arranged in systematic books, according to their chemical compositions, and not according to their external characters and forms, these varieties are included in the quartz family, because, like quartz, they are composed almost entirely of the earth called *silex*. These varieties also agree, in many of their external characters, with the description of quartz already given. They scratch glass, give fire with steel, and most of them are more or less transparent, though, as already stated, they want the vitreous or glassy lustre, which is so distinct in pure quartz. These species, or varieties, are *flint*, *chalcedony*, *opal*, and *carnelian*.

*Flint* is of a grey, or blackish colour, of various shades. Its lustre is glimmering, and its fracture smooth and concave, the fragments being sharp edged. It is found in rounded nodules in chalk beds, and hence these nodules are always covered with a coat of chalk. It gives lively and copious sparks with steel. It is never transparent, but generally translucent in thin pieces.

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What are the names of some of the varieties of quartz?—How does the student, having ascertained that his specimen belongs to the quartz family, proceed to find its name?—What is meant by *granular quartz*?—How are minerals arranged in systematic books?—What are the species of uncrystallized quartz mentioned?—What is the colour of flint? What its fracture, and in what form is it found?



*Chalcedony* is characterized by a milky, or cloudy translucency, when held between the eye and the light, the colour being similar to that of milk diluted with water. It is never transparent, but some specimens, or parts of the same specimen, are more translucent than others, and hence its clouded or spotted appearance.

*Cacholong* is a variety of chalcedony, of a milk white colour, and nearly opaque. It is commonly found united with chalcedony, the two minerals alternating with each other in layers, in the same specimen, and producing stripes or zones, alternately translucent and opaque.

*Carnelian* is thus named because its colour resembles that of flesh. But although pale red is one of its most common colours, it is sometimes found blood red, yellowish red, and nearly white.

*Agate* is made up of carnelian, chalcedony, cacholong, and often of several other minerals arranged in stripes, dots, zones and clouds, of different colours. Each variety of the mineral of which it is composed having its distinct shade of colour, although the whole are joined so as to compose a single piece.

Agate bears a high polish, and exhibiting such a variety of colours, is often a very beautiful mineral. It is in common use in jewelry, and is employed for the tops of snuff boxes, seals, &c.

*Opal*. There are several varieties of this mineral, which differ from each other chiefly in respect to colour. The *precious opal* may readily be known by the variety or play of colours, which proceed from the interior of the stone, as it is turned in different directions towards the light. *Common opal* is of a milk-white colour, and is translucent. It emits slight changes of colour as its position is varied in respect to the light; but it never displays that beautiful effulgence of the prismatic rays for which the precious opal is so distinguished.

There are still many species of minerals not belonging to the quartz family, which scratch glass, and give fire with steel. These will be described in their proper places, and the means of distinguishing them pointed out.

Having given this short account of the quartz family, we will resume that of the limestone species.

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By what appearance is chalcedony characterized?—How may cacholong be known from chalcedony?—Whence does carnelian derive its name?—What is the colour of this mineral?—Of what minerals is agate composed?—What is the appearance of agate, and what its colours?—What are the uses of agate?—How may the precious opal be known?—What is the colour of common opal?

## CARBONATE OF LIME.

The means of distinguishing limestone, or carbonate of lime, from the silicious minerals, and both these from the ores of iron, have already been pointed out.

Carbonate of lime, on some accounts, offers one of the most important and interesting mineral families which the earth presents. All the beautiful marbles, of which there is so great a variety of colours, are carbonate of lime.

The varieties of this species differ greatly in respect to form, lustre, transparency, fracture and colour, but we have seen that they all agree in yielding to the knife, effervescing with acids, and in burning to quicklime when strongly heated.

Some of the principal varieties of carbonate of lime are *common limestone*, *granular limestone*, *stalactite*, *satin spar*, *fetid carbonate of lime*, *chalk*, *bituminous limestone*, and *calcareous tufa*.

*Common, or compact limestone.* The colour of this variety is most commonly greyish white, or yellowish. Sometimes also it is reddish, bluish, or nearly black. Its lustre is glimmering, or dull, and its fracture is uneven. This is a common rock, and in some countries forms mountains. It is burned to form quicklime, of which mortar for laying bricks is made.

*Granular limestone.* This, when broken, appears to be composed of small grains, or crystals, which have a shining or glimmering lustre. It is of various colours, as yellow, greenish, brown and black; but the most common colour is white, and when pure its fracture very nearly resembles that of loaf sugar. This is the kind of carbonate of lime which is so extensively employed under the name of *marble*, and of which statues, monuments, and architectural decorations are made.

*Stalactite.* This variety occurs in long, tapering, solid or hollow concretions, which in form resemble icicles. Its colour is commonly yellow, or grey. It is formed by the percolation of water through limestone rocks, which thus becomes impregnated with particles of lime. As the water drops slowly through the crevices of the rocks into the cavern

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What is said of the importance of the limestone family?—What are the names of some of the principal varieties of the limestone family?—What is the colour and appearance of common limestone?—What is its use?—What is the appearance of granular limestone?—To what important uses is this species applied?—In what form does stalactite occur?

below, it evaporates, and leaves the particles of lime, which, adhering together, form the stalactite. Sometimes the broken limbs of trees serve to conduct the water from the roof to the floor of the cavern, and thus become covered with a crust of limestone.

*Satin spar.* The colour of this beautiful variety is white, or yellowish white. It consists of fine, delicate fibres, adhering closely together, and forming compact masses, which, when polished, have the lustre of satin, and hence its name. It is commonly found in thin pieces, encrusting other minerals, or filling their crevices.

*Calcareous spar.* This variety is found in crystals, and therefore will not be described until we come to the subject of crystallization.

*Fetid carbonate of lime,* is white, or greyish white, and does not differ in external appearance from common limestone. But when struck, or scratched with a knife, it exhales a most offensive odour, resembling that of rotten eggs. This is owing to a small quantity of bitumen which it contains.

*Chalk.* The appearance of this variety is well known. It effervesces strongly with acids, adheres to the tongue, and burns to quicklime. It is nearly pure carbonate of lime.

*Calcareous tufa.* Its colour is grey, brown, or yellowish. It occurs in porous, spongy masses, often containing leaves, sticks of wood, pebbles, and other impurities. It is formed by the gradual deposition of lime from the water of springs, or that which has flowed over calcareous rocks. It is consequently an impure carbonate of lime, containing such foreign materials as happen to fall into the water by which it is formed.

#### IRON ORE.

The *ores of iron* are the third family of minerals which we propose here to examine.

The varieties of this ore are numerous, and some of them highly interesting to the mineralogist, on account of their great beauty of colour, or natural brilliancy. Many of them are magnetic, that is, are attracted by the magnet in the natural state, while others, being combined with sulphur, oxygen,

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How is this variety formed?—What is the colour of satin spar?—In what situations is this mineral found?—How does fetid carbonate of lime differ from common limestone?—To what is the odour of this species attributed?—What is the composition of chalk?—What are the colours of calcareous tufa, and in what form does it occur?—What is said of the varieties of iron ore?

or the other metals in large proportions, do not move the magnet until heated, by which the sulphur, or oxygen, is driven off.

The most common magnetic iron ores are the following, some of which occur in crystals: *magnetic oxide of iron, specular oxide of iron, micaceous oxide of iron, brown oxide of iron, magnetic sulphuret of iron*. Most of these varieties possess more or less of the metallic lustre, and considerable weight, or specific gravity.

*Magnetic oxide of iron.* This species is found in crystals of an iron black colour, and often with considerable lustre. It also occurs in masses, in thin plates, and in the state of sand. Some specimens of this ore attract iron, and when suspended by a string will turn one of its sides to the north, thus being natural magnets.

*Native iron.* This variety is found in masses, and nearly resembles wrought iron. It is malleable and may be welded like purified iron. It however is not pure, but contains minute quantities of lead, or copper. It has only been found in a few places and in small quantities.

*Micaceous oxide of iron.* This is of an iron black colour, and is found in masses composed of thin laminæ, or layers, which are easily separable from each other, often with the finger nail. In very thin pieces it permits the light to shine through it, and then appears of a blood red colour.

*Specular oxide of iron.* This beautiful variety occurs in crystals, the forms of which will be described in another place. Some of these crystals possess the polish of burnished steel; others are tarnished, and appear of a red, blue, or yellow colour. Sometimes all these colours will be seen on the different faces of the same crystal. The crystals, which are polished by the hand of nature, are not liable to rust, but hold their brightness from year to year without change.

*Brown oxide of iron.* The colours of this species are brown, blackish brown, or yellowish brown. It is found in masses which are nodular, or amorphous. Externally these masses present smooth polished surfaces of a black colour, appearing as though they had been carefully smoothed and then varnished by the hand of man. The fracture presents a fibrous structure, with an earthy aspect. The powder of

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What magnetic ores of iron are mentioned?—What is the colour of magnetic oxide of iron?—What peculiar and valuable property has this ore?—What is said of native iron?—What is the form of micaceous oxide of iron?—What is said of the form and appearance of specular oxide of iron?—What is said of brown oxide of iron?

this mineral is always brown, and it is seldom magnetic unless first heated on charcoal.

*Magnetic sulphuret of iron.* The colour of this species is yellowish with a tinge of red, being of a shade between the colours of brass and copper. It is found in masses, and sometimes, though rarely, in crystals. Its lustre is somewhat metallic, but it turns brown by exposure to the air. The magnetism of this species is a remarkable property, it being the only native compound of sulphur and iron which moves the magnet in its natural state. This property is probably owing to small particles of iron existing in the mineral, which are not combined with the sulphur.

There are a number of species of iron ore, which, as has already been stated, do not attract the magnet until they have been heated on charcoal with the blow pipe. Among these are the following, viz. *argillaceous oxide of iron*, *red oxide of iron*, and *bog iron ore*.

The *argillaceous oxide*, is sometimes called *clay iron stone*, because it is in part composed of clay. Its colours are grey, bluish brown, and dull red. It occurs in masses of various shapes; sometimes in flat irregular pieces, and sometimes in globular, or rounded masses. It is without lustre, has an earthy fracture, may be scratched with a knife, and often adheres to the tongue.

*Red oxide of iron.* Its colour is reddish brown, but its powder is blood red, or dark reddish brown. Its aspect is dull, but somewhat metallic, and when broken its texture appears fibrous, and often radiated. A variety of this ore is called *red hematite* or *blood stone*, and is employed in polishing buttons.

*Bog iron ore.* This is the most common of all the ores of iron. Its colours are yellowish brown, and reddish grey; its fracture is uneven, lustre dull and earthy, and it is often so soft as to be rubbed to powder between the fingers. Sometimes it appears spongy or porous, as though it had been melted. This ore appears to be a deposit from water which comes from beds of iron ore and therefore is constantly forming in the earth.

Having now described a few of the varieties of quartz,

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What is the colour of the magnetic sulphuret of iron?—What is said to cause the magnetic property of this species?—What is the appearance of argillaceous oxide of iron?—In what forms does it occur?—What is the colour of red oxide of iron?—What is the use of the ore?—Is bog iron ore a rare, or a common mineral?

carbonate of lime, and iron ore, we will in the next place endeavour to point out the means of distinguishing some of their crystalline forms from each other.

Substances crystallize under a great variety of forms, but it is a wonderful fact, that all crystals composed of the same kind of matter have exactly the same forms. Thus common salt when dissolved in water, and allowed to stand until the water evaporates, forms cubes, or square crystals, and it will be found on examination, that these crystals, whatever their size may be, have all of them precisely the same figure. The like regularity is observed with respect to all crystalline substances, each substance having a certain form under which it always appears, wherever it is found. Some crystals, however, are subject to what mineralogists call *modified forms*, that is, to slight changes in their forms, a subject which will receive attention in another place.

To investigate, and describe the forms of crystalline bodies, is the object of *Crystallography*, which is one of the most interesting branches of the science of Mineralogy.

The different parts of a crystal have different names, otherwise no precise ideas could be conveyed in writing or speaking, of their forms as a whole. The terms employed for this purpose are few in number, and are easily understood.

Let the student in the first place make the model of a crystal, by cutting a piece of pine wood, into the form of an oblong square, about two inches in length, and the third of an inch in diameter. At one end leave the wood at right angles with the sides, so that it will stand on that end when set upright on a flat surface. Then form a pyramid at the opposite end by cutting away the wood, at a short distance from the *extremity*, in such a manner as to form four angles which meet at a point, and four oblique triangular faces, which shall correspond with the four faces of the oblong square. Then there will be formed a quadrangular or four sided prism, terminated by a four sided pyramid, the faces of the pyramid being set on the lateral faces of the prism.

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Are all the crystals of the same substance of the same form?—What is said of the crystallization of common salt?—What is said of modified forms?—What is the object of Crystallography?—What is said of the necessity of naming the different parts of a crystal?—How is the student to make the model of a crystal?—How is the pyramid to be formed?—What is the name of the crystal so formed?

Fig. 1. Such a crystal is represented by fig. 1. The names of its several parts are as follows. *Lateral planes* are the four long sides or faces of the prism *a*. These four sides make the *body* of the crystal.



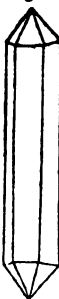
*Terminal planes* are the triangular planes or faces by which the crystal is terminated, marked *o*. The four terminal planes meet at the same point and form the *pyramid* of the crystal.

*Lateral edges* are the four edges of the crystal, and are formed by the meeting of the lateral planes.

*Terminal edges* are the angles formed by the meeting of the triangular planes of the pyramid.

The most common, perfect crystals to be obtained, are those of quartz, or rock crystal. These are six-sided prisms terminated by six-sided pyramids. It is not uncommon to find such crystals perfect at both extremities, and as colourless and as highly polished as the finest glass. Such a crystal is represented by fig. 2.

Fig. 2.



This form is, however, often modified in such a manner as greatly to affect its appearance. Sometimes two opposite faces are so broad, and the others consequently so narrow, as to give the crystal a flattened shape, and at the same time one of the faces of the pyramid will be so large as to give the termination the appearance of obliquity, as represented by fig. 3.

When crystals of quartz are implanted in groups, with their lower extremities attached to some other substance, or to each other, as is often the case, then only one extremity, with perhaps a part of the prism, is perfect, as in fig. 3.

Fig. 3.

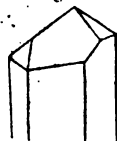
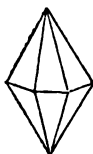


Fig. 4.



Sometimes the prism is so short that the pyramids nearly meet, there remaining only the remnant of a prism between them. In other cases the prism entirely disappears, leaving the crystal a double six-sided pyramid, or two six-sided pyramids joined base to base, as represented by fig. 4.

What does fig. 1 represent?—What are the lateral planes?—Which is the body of the crystal?—Which are the terminal planes?—How is the pyramid of the crystal formed?—Which are the edges?—Which the terminal edges?—What mineral generally affords the most perfect crystals?—What is the form of crystallized quartz?—Why do crystals of quartz often appear oblique?—What is the form of fig. 4?

Having examined some of the crystalline forms belonging to quartz, we will now compare them with such forms of carbonate of lime as they most resemble, so that the pupil will be enabled to distinguish the difference.

Crystals of carbonate of lime sometimes consist of two six-sided pyramids, joined base to base, forming solids with the same number of sides, and of a similar shape with the crystal of quartz just described, fig. 4. But the figures of the planes, or faces, of which the pyramids are composed, are different in the two minerals. In the quartz the line forming the base of each triangular face of the pyramid is horizontal, making the two angles at each side of the base equal to each other, giving the form of each face that of an *isosceles triangle*.



In the crystal of carbonate of lime, fig. 5, the bases of the triangular planes are formed by oblique, instead of horizontal lines, making the two angles at the base unequal, each face having the form of a *scalene triangle*. By comparing fig. 4 and 5, this difference will be obvious.

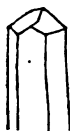
The crystals of carbonate of lime just described, are quite common, and are familiarly known under the name of *hog's tooth spar*. These crystals are most commonly grouped, or set so near each other, that only one of the pyramids are distinct, as in fig. 6.

Fig. 6.



These crystals appear in their general outline to be three-sided pyramids, but on closer inspection, each side will be found to contain two faces, inclined to each other under a certain angle.

Fig. 7.



Another crystalline form under which carbonate of lime appears, is that of a six-sided prism, terminated by a low pyramid, consisting of pentagonal, or five-sided faces, fig. 7. These crystals are also most commonly implanted in groups so that only one of their pyramids can be distinguished.

### CRYSTALS OF IRON.

The crystalline forms of iron, together with the colour and

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Do the crystals of carbonate of lime, and those of quartz resemble each other? What is the figure of the plane, forming a face of a pyramid of quartz? What is the figure of any face of which a pyramid of carbonate of lime is formed? How do the bases of these two figures differ? How many faces has a pyramid of carbonate of lime? What does fig. 7 represent?



metallic lustre which they present, differ so widely from those of the crystals we have already described, that the student will find no difficulty in distinguishing them from the quartz and carbonate of lime. These will therefore be described in another place.

#### CRYSTALLOGRAPHY.

There is little difficulty, as we have already seen, in distinguishing the common minerals from each other, and especially where there is so much difference between them as there is between quartz, carbonate of lime, and the ores of iron. But there are many minerals, as before observed, which scratch glass and give fire with steel, besides the varieties of quartz; and in addition to the characters belonging to this species and to those of carbonate of lime and iron, there are peculiarities which appertain to other species, not included in the description of these.

It becomes necessary, therefore, before we proceed further in the practical, or demonstrative part of mineralogy, to define more particularly than we have done, the principles of this science.

None of the characters belonging to minerals, are so important in a practical relation as their crystalline forms; for as these forms, or their modifications, are peculiar, or nearly so, to each species, there is often nothing more wanted to distinguish one mineral from another with the greatest certainty, than a knowledge of the difference between the forms of their crystals.

Now although there are a vast variety of forms under which the crystals of different substances appear, yet on close examination it is found, that all these are only modifications of a few predominant, or fundamental forms, and to which they may all be traced.

To make this understood, we will take the cube, which is a common form, as an example. If we take a long, square piece of wood, of an inch in diameter, and cut off an inch from its end, we shall have a solid, called the cube. The cube has six faces, or planes, eight solid angles and twelve edges. Now if we cut off each of the eight solid angles, or corners, we shall have a figure bounded by fourteen faces in-

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What is said of the crystalline forms of iron? What is said of the practical use of crystallography? What is said of distinguishing minerals by their crystalline forms? How many faces, solid angles, and edges has the cube? If the eight corners be cut off, how many faces will the figure have?

stead of six faces as before. But still the predominating form of this solid would be that of the cube, because a proportion of the six original faces would remain, and the whole figure would still resemble the form of a cube more nearly than that of any other figure with which the mind is familiar. An idea of such a figure would therefore be most readily conveyed by describing it as a cube with all its solid angles *truncated* or cut off.

The same method is followed with respect to other crystalline forms; that mathematical figure which it most resembles being selected as the foundation of the description, and then the deviations from this form pointed out.

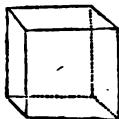
#### PREDOMINANT FORMS OF CRYSTALS.

On the examination of a vast variety of crystals, including all the forms which are known to occur, it has been found that their predominating forms may be reduced to seven, and consequently that from these, all the actual forms which occur, arise by various modifications.

The predominant forms of crystals are the following, viz. the *prism*, *hexahedron*, *pyramid*, *dodecahedron*, *icosahedron*, *table*, and *lens*.

Fig. 8. The *prism*, fig. 8, has any number of sides or lateral planes, from three to nine, or more. It is the most common of all the predominant figures. Examples, *quartz*, *schorl*, *beryl*, *calcareous spar*, &c. The prism is sometimes many inches in length, and is commonly terminated by a pyramid at one or both extremities, but it is sometimes so short as merely to separate the bases of the two pyramids as already noticed when speaking of quartz.

Fig. 9.



The *hexahedron*, or six-sided figure, fig. 9, is a solid with six equal faces and eight solid angles. It therefore includes the cube and the rhomb, fig. 10,

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What will be the predominant form after the removal of the corners? What is meant by predominant forms? How many predominant forms are there? What are the names of these forms? How many sides has the prism? What minerals afford examples? What is said of the length of the prism? How many sides has the hexahedron?

Fig. 10.



Fig. 10, the *acute rhomb*, is sometimes described as a double three-sided pyramid, in which the lateral planes of one, are set on the lateral edges of the other. The crystals of carbonate of lime assume both these forms.

Fig. 11.



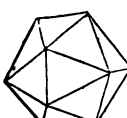
The *pyramid*, fig. 11, like the prism, has an indefinite number of sides, or triangular planes, converging to a point, which is called the summit, or apex. The wide part opposite to the summit is called the base of the pyramid. The pyramid is usually set on the top of a prism. This figure is very common. Ex. quartz, emerald, carbonate of lime, &c.

Fig. 12.



The *dodecahedron*, fig. 12, has twelve pentagonal, or five-sided faces, and twenty solid angles. This figure is rare. Ex. garnet, and sulphuret of iron.

Fig. 13.



The *icosahedron*, fig. 13, is a solid bounded by twenty triangular planes and twelve solid angles, so that each solid angle is formed by the meeting of five planes, as may be observed on inspecting the figure. Example, iron pyrites.

Fig. 14.



The table, fig. 14, may be considered a very short prism. It has two broad faces or planes, opposite to each other, which are surrounded by an indeterminate number of smaller planes.

These planes may be at right angles with the principal faces, or not. A thin section from the end of the prism, fig. 8, would form a four-sided table. This figure occurs but rarely. Ex. sulphate of barytes, mica.

In an extensive examination of crystalline bodies, a great variety of modifications of these predominant, or fundamental

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What is the form of fig. 10? What number of sides has the pyramid? Which is the base and which the apex of this figure? How many faces has the dodecahedron? What form has the icosahedron? What mineral occurs in the form of fig. 13? What is the form of the figure called the table? What are examples of this figure?

forms, will be found to occur, though it is believed that few, if any, will be found, which may not be referred to one of the figures described above. The number of changes which may take place in some of them, and still the predominating form be obvious, are very numerous. Thus the prism may have the least possible number of sides, which is three, or it may have twelve or more, and some of these faces may be broad and others narrow, and still the figure may be that of a prism. The length of the prism may also be only the twelfth of an inch, or it may be a foot, or more.

The hexahedron has six equal faces, but these may be at right angles with each other, as in the cube, or they may be oblique, as in the rhomboid, fig. 10.

The pyramid occurs with three, four, six, or eight sides, all ending at the same point.

Fig. 15.

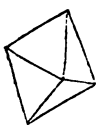


Fig. 16.

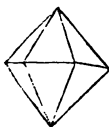
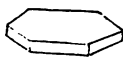


Fig. 17.



The pyramid is also, often double, that is, two pyramids are joined base to base, as already noticed. Fig. 15 is a double four-sided pyramid, forming an eight-sided figure called a *regular octohedron*.

Fig. 16 is a solid with twelve equal sides, called a *dodecahedron*, and is formed by joining two six-sided pyramids base to base. Examples of the first kind are found in the diamond, zircon, and fluor spar, and of the second in quartz, amethyst, and carbonate of lime.

The table, fig. 17, like the prism, has any number of sides from three to twelve. This figure is a six-sided table. A great variety of other modifications will be found to occur.

It is supposed, as remarked above, that to one or the other of these predominating forms, all the actual forms under which crystals occur may be referred. But it requires an experienced eye to detect the traces of these predominating forms in every instance. Crystals are frequently so changed in their appearance, in consequence of *truncation* and *bevelment*, that only slight traces of their predominant figures remain.

What is said concerning the modifications of fundamental forms? How may the prism be modified? How may the planes of the hexahedron vary? What regular figure is formed by joining two four-sided pyramids base to base? What solid is formed by joining two six-sided pyramids in the same manner? How many sides may the table have?

## TRUNCATION.

By truncation is meant, that certain edges, or angles of the crystal are cut off, or replaced by planes. If we take a cube of wood and cut off all its corners, we shall have a cube with all its solid angles truncated, and replaced by planes.

Now, although it is not probable that nature works in this manner, first completing and then mutilating her performances, yet the appearance of the crystal, and the idea it is wished to convey, are precisely the same as though this had actually been done.

Some crystals are truncated but slightly, and only on their edges or angles, while others are so deeply truncated as to entirely change their appearance. Sometimes only the angles or sharp edges are taken off; in other instances the half of a pyramid will be found wanting.

Fig. 18.



Fig. 18 represents an octohedron, or double four-sided pyramid, with all its edges slightly truncated, forming narrow planes instead of edges. By comparing this fig. with fig. 15, the difference caused by slight truncation will be observed, the predominating form remaining the same in both cases. Examples of this kind of truncation occur in native gold, red oxide of copper, and sulphuret of zinc.

Fig. 19.

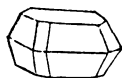


Fig. 19 represents a crystal of black oxide of uranium, which, if perfect, would consist of an octohedron, or double four-sided pyramid. But both pyramids are so deeply truncated as to form a table rather than an octohedron. The edges being also truncated, the whole has but little resemblance to the predominating form. But still, on careful examination, it will be obvious from the broad faces remaining of each pyramid, that the octohedron is the predominant figure, notwithstanding these apparent mutilations.

## BEVELMENT.

*Bevelment*, like truncation, is applied to the edges and angles of crystals. It is nothing more than a double truncation, producing on the perfect crystal, two new planes, and three obtuse angles, instead of one edge or angle. If we take a

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What is meant by truncation?—How may truncation be illustrated by a figure of wood?—What is observed concerning the degrees of truncation?—Explain fig. 18.—What minerals present examples of this kind of truncation?—Explain the change produced in fig. 19 by truncation—Explain what is meant by bevelment.

four-sided prism of wood, and with a knife shave off the edge, and a part of the two contiguous lateral planes obliquely, so as to form two new planes, which meet and form a new edge, we shall have an example of bevelment.

This change is not so common as that produced by truncation. It generally affects the edges, sometimes the terminal planes, and occasionally the corners or solid angles of crystals.

Fig. 20.

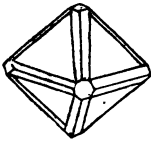
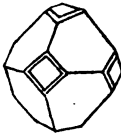


Fig. 20 represents an octohedron, or double four-sided pyramid, bevelled on all its edges and angles; the three lines showing that two new faces and three new angles have been formed on the planes of each pyramid. This modification will become more apparent, by comparing fig. 20 with

fig. 15, which is an octohedron with all its edges and angles entire. Examples, galena, and fluor spar.

Fig. 21.



Sometimes the solid angles, or corners only, are bevelled, while the edges remain entire. Fig. 21 represents a crystal of galena, or sulphuret of lead, in illustration of such a change.

In these examples it may be observed that the beveling process has only affected the angles of the crystals, while the predominating octohedron forms the chief outline of each figure. The change of figure is therefore not so great as is often produced by truncation.

#### PRIMITIVE FORMS OF CRYSTALS.

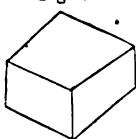
By *primitive form* is meant the nucleus, or basis of the crystal, and which is often concealed within the secondary, or external form. The primitive form may, or may not, be the same with the external form. In most instances they differ widely from each other. In the formation, or growth of the crystal, the primitive form is supposed to be first produced, and the secondary form to arise from the deposition of particles on this. In this manner the secondary form either entirely conceals the primary, or, as is sometimes the case, leaves one or more of its faces visible.

How may bevelment be illustrated by art?—Explain the change produced in fig. 20, by bevelment—What examples occur of fig. 20?—Explain fig. 21—What examples?—What is meant by primitive form?—Is the primitive form the same with the external form?—Explain how the primitive form is concealed by the secondary.

Whatever may be the external form, each primitive is always found to exist under precisely the same angles, and the same primitive is found to be the basis of many species of minerals, differing entirely in composition from each other. As the primitive forms throughout the mineral kingdom, amount only to six in number, it is obvious that many crystals, though differing in all respects from each other, must have the same primitive. Thus the cube is the primitive form of the crystals of *muriate of soda*, or *common salt*, and also of the *sulphurets of lead and iron*. The octohedron is the primitive of the *diamond*, *fluete of lime*, *spinelle*, and the *red oxide of copper*.

The following are the primitive forms, viz. the *parallelepiped*, *octohedron*, *tetrahedron*, *hexahedral prism*, *dodecahedron with triangular faces*, and *dodecahedron with rhombic faces*.

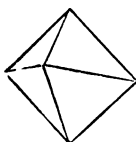
Fig. 22.



The *parallelepiped*, fig. 22, includes the cube, the four-sided prism, the rhomb, or any other figure having six faces, the two opposite ones being parallel with each other. When its angles are equal in every direction, and the size of its planes alike, it is the cube. When this figure is extended so as to make the length greater than

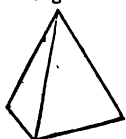
the breadth, it becomes a four-sided prism, and when the angles are oblique, that is, alternately acute and obtuse, it is a rhomb.

Fig. 23.



The *octohedron*, fig. 23, has eight triangular faces, four of which meet at points opposite to each other. This figure is therefore sometimes described as two four-sided pyramids joined base to base. It is subject to various modifications. Thus the two pyramids may be depressed or elongated. The base may be square, or oblique, or the faces of the pyramids may be scalene, or isosceles triangles. Examples, red oxide of copper, native lead.

Fig. 24.

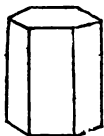


The *regular tetrahedron*, fig. 24, is a solid contained under four similar equilateral triangles, and is not subject to any variety of form. Examples, grey sulphuret of copper, sulphuret of zinc.

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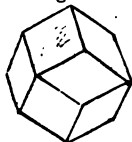
Is the same primitive form, the basis of several secondary forms?—How many primitive forms are there, and what are these forms?—What are the forms included under the parallelepiped?—How is the octohedron modified?—Where do examples occur?—What is the form of the regular tetrahedron, and what examples occur of this form?

Fig. 25.



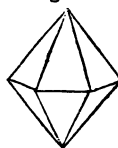
The *regular hexahedral prism*, fig. 25, is a solid contained under eight planes. It is a six-sided prism, bounded by a terminal plane at each end. This figure is variable in the proportions between the length, or height of the prism, and the extent, or diameter of the terminal planes.

Fig. 26.



The *dodecahedron with rhombic faces*, fig. 26, is a solid contained under twelve rhombic planes, all similar to each other, and is not subject to any variety of form. Example, garnet.

Fig. 27.

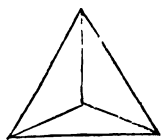


The *dodecahedron with triangular faces*, fig. 27, is bounded by twelve triangular planes, and is sometimes described as two six-sided pyramids joined base to base. It is variable in the proportions of the height of the pyramids and the diameter of the base. Ex. quartz.

#### MOST COMMON FORMS OF CRYSTALS.

The pupil in Mineralogy, will find his progress greatly facilitated, by acquiring, in this place, such a knowledge of Crystallography as to be able to understand and explain the following figures. For this purpose let him take any soft substance, as a piece of pine wood, and with a knife form the solid figures as he proceeds. In this way he will at once obtain more correct ideas than could be conveyed by the most labored descriptions.

Fig. 28.



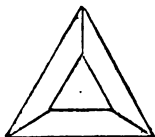
The *Regular Tetrahedron*. This figure is bounded by four oblique planes or faces, and has four points, or solid angles, and six edges.

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Describe the form of the hexahedral prism—How many faces has the dodecahedron?—How do the figures 26 and 27 differ?—What varieties of fig. 27 occur?



Fig. 29.



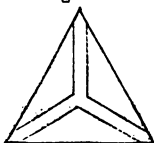
The same with the summit truncated or cut off.

Fig. 30.



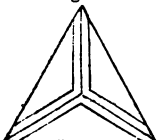
The same with all the corners, or solid angles truncated.

Fig. 31.



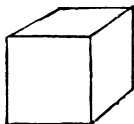
The same with the edges truncated.

Fig. 32.



The same with the edges bevelled.

Fig. 33.



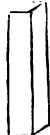
The *Cube* has six equal, square faces, eight corners, or solid angles, and twelve edges.

Fig. 34.



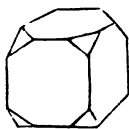
The *Regular Square Table*. It has the same number of solid angles and edges with the cube. If the cube be divided in the middle, two square tables would be formed.

Fig. 35.



**A Regular Quadrangular Prism.** This has the same number of faces, angles, and corners, with the cube. If two, or three cubes, be laid one on the other, this figure would be formed.

Fig. 36.



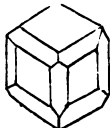
The *Cube*, with the corners truncated.

Fig. 37.



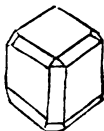
The same, more deeply truncated.

Fig. 38.



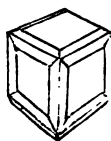
The same, with the edges truncated.

Fig. 39.



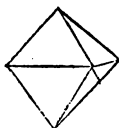
The same, with the corners and edges truncated.

Fig. 40.



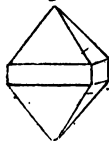
The *Cube*, with the edges bevelled, forming two planes and three edges, instead of one edge.

Fig. 41.



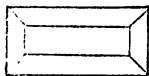
The *Regular Octohedron*. This figure is contained under eight triangular planes, or faces, six solid angles, and twelve edges.

Fig. 42.



The *Octohedron*, with a short prism interposed between the pyramids.

Fig. 43.



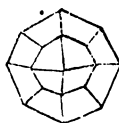
The *Elongated Octohedron*, with the summits truncated.

Fig. 44.



The *Rhomb*. This figure differs from the cube, in having its contiguous faces inclined to each other under various angles, instead of being at right angles.

Fig. 45.



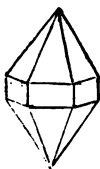
A figure bounded by *twenty-four* sides. The garnet sometimes is found under this form.

Fig. 46.



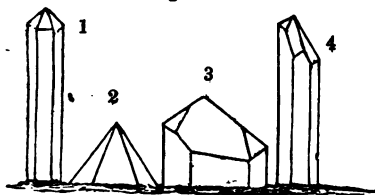
The *Dodecahedron*, with the triangular faces.

Fig. 47.



The same, with a short prism interposed, on which the two pyramids stand.

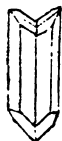
Fig. 48.



Here is (1) the *Hexahedral*, or *Six-sided Prism*, terminated by a 6-sided pyramid; (2) A *Pyramid*; (3) An *Irregular Pyramid*, standing on a short prism; (4) the same, but still more

irregular. Crystals of quartz are found under all these forms.

Fig. 49.



A *Macle*, or *Hemitrope* crystal, formed by the junction of two halves, one of which is inverted.

Fig. 50.



Two crystals crossing each other. *Staurolite* occurs in this form.

By obtaining, and examining closely, the solids represented by the above cuts, the student will not only gain a general knowledge of crystalline forms, but will also understand the right application of the terms by which they are designated. Thus, the difference between the *Tetrahedron*, and the *Tetrahedral*, or *Four-sided Prism*, is obvious. The *Tetrahedron* has four sides only, while the *Tetrahedral Prism* has four sides, more or less extended, surrounding its axis, besides its terminations, which may consist of from one to four, or more faces at each extremity. This figure is also called the *Quadrangular Prism*.

The *Hexahedron*, or *Cube*, has six equal faces, while the *Hexahedral*, or *Six-sided Prism*, has six sides surrounding its axis, besides its terminations.

The *Octohedron* is bounded by eight faces, while the *Octohedral Prism* has eight contiguous planes, besides its terminations.

#### MECHANICAL DIVISION OF CRYSTALS.

We have stated that the primitive forms of crystals are often concealed within their actual, or external forms. This fact could only have been ascertained by the mechanical division, or cleavage of the crystals, which consists in the removal of their external layers, or covering. This operation is founded on the fact that crystals are made up of thin slices, or layers, placed one upon the other, and that these are separable, and may be removed by mechanical means. These layers are nicely fitted to each other, though in many crystals the seams, or natural joints where they meet, are readily distinguished by the eye. This is particularly the case in galena, or sulphuret of lead, in fluor spar, in common felspar, and in the rhombic carbonate of lime. In other minerals, as in quartz and some crystals of iron ore, they are not so apparent, though by close examination their direction may be ascertained in most minerals. It is between these natural joints that cleavage is to be attempted. The instruments for this purpose are various, and depend on the nature of the mineral to be divided. The sulphuret of lead and zinc, in which these joints are quite apparent, require only a sharp knife to be introduced between them, the mineral being held with the hand on a table. Oxide of zinc is best cleaved with pincers, having sharp edges, while many varieties of carbonate of lime yield to a slight blow with the knife. Some minerals require to be heated, and in that state to be plunged into cold water, by which fissures will be produced in the direction of their natural joints, after which cleavage can be effected.

The faces produced by cleavage are always smooth and shining, and are thus easily distinguished from the surfaces made by fracture, which never present this appearance.

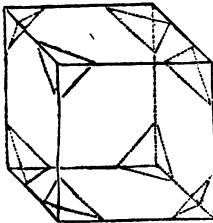
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What is meant by the mechanical division of crystals?—What crystals are mentioned as illustrations of this subject?—On what part of the crystal is mechanical division to be attempted?—What instruments are employed in the mechanical division of crystals?—How are the faces produced by cleavage distinguished from those produced by fracture?

We have already stated that in some instances the primary and secondary forms are the same. In such cases cleavage only diminishes the size of the crystal, but does not in the least change its form. Crystals of rhombic carbonate of lime are an example. Cleavage can only be effected in this, in the direction parallel to all its plane surfaces, and hence, however far the process is carried, the shape of the specimen will still remain a rhomboid as at first. In all cases where the primary and secondary forms are the same, the same effect only will be produced by cleavage. In those instances where the primary and secondary forms are different, an entire change in the figure of the crystal is often produced by cleavage. In some minerals these two forms would seem to have no connection with each other. Thus the secondary form of fluor spar is most commonly the cube, while its primary is the octahedron.

In the process of cleavage, the primitive form is known to be obtained, when it is found that the layers continue to separate in directions parallel to all its sides, whatever its figure may be. It will be obvious that when this is found to be the case, the figure of the crystal will not be changed, but only its size reduced by continuing the cleavage.

Fig. 51.



To make the nature of mechanical division more obvious, let fig. 51 represent a crystal of fluor spar. The form is that of a cube, and cleavage can be effected only across its corners. The cube, it will be remembered, has six equal sides, and eight solid angles or corners. If, therefore, we cleave off each of these corners, we shall form a figure having fourteen faces, viz. eight new triangular planes instead of the corners, and a part of the six original faces of the cube. Now it is obvious by the figure, that if the process be continued, and layer after layer be removed from each of the new faces, making the opposite planes parallel with each other, that the cube will finally disappear, and that we shall

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When does cleavage produce a change of form in the crystal, and when not?—In the process of cleavage, when is the primitive form known to be obtained?—Explain fig. 51, and show in what manner cleavage is to be effected on a crystal of fluor.

Fig. 52.



obtain a solid having eight plane faces instead of eight corners, thus forming the primitive octohedron which is seen in the middle of fig. 52.

This process may readily be illustrated by a piece of cork, or potatoe, and a sharp knife.

Having obtained the octohedron, it will be found that the cleavage of the mineral may still be continued, but that the form of the crystal will not thereby be changed; hence this is the primitive form of fluor spar.

Fig. 53.

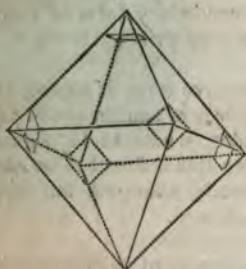


fig. 53,) where the dotted lines show the new faces formed by cleavage. Now as the octohedron has six corners, and the cube six sides, if we continue the cleavage so as to form parallel faces, we shall finally obtain a figure having six equal sides, and eight solid angles, or a cube.

Fig. 54.



Fig. 54 shows that if the truncation be pursued on each of the six corners of the octohedron, the cube contained within the outline of that figure will be formed.

This experiment may be made on an octohedral crystal of sulphuret of lead, and a brilliant cube obtained, whose form will not be changed by further cleavage. This, therefore, is the primitive form of sulphuret of lead. These examples are suf-

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What is intended by fig. 52?—Explain what is said concerning fig. 53.—How many faces and corners has the octohedron?—Show how the octohedron will be converted into the cube by cleavage?—On what substance may this experiment be made?

ficient to give the beginner an idea of the nature of the mechanical division, or cleavage of minerals.

#### ANGLES OF CRYSTALS.

We have stated that the constancy of the angles under which crystalline bodies appear, is often the surest means of distinguishing them.

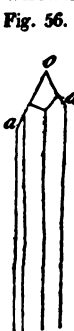
Notwithstanding the modifications of form which the crystals of many substances present, still it is found that each variety of the same substance afford an invariable quantity in their angular admeasurements. Thus, if we take a six sided crystal of quartz, and ascertain the quantity of the angle which one of the lateral planes makes with its corresponding terminal plane, we shall have the angle which all other crystals of quartz give at the junction of their lateral and terminal planes. And so if we measure the angle produced by the meeting of any two opposite faces of a pyramid of quartz, the same angle will apply to the corresponding part of any other crystal of the same substance.

Fig. 55.



Thus, in the crystal of quartz fig. 55, the angle which the inclination of any face of the pyramid makes with its corresponding lateral plane, that is at  $a$ , or  $a$ , is equal to  $141^{\circ} 40'$ , and this angle will be found the same on the corresponding part of any other crystal of the same substance, from whatever part of the world it may come. In the same crystal, the inclination of the two opposite faces of the pyramid, meeting at  $o$ , will be found under an angle of  $75^{\circ} 22'$ , and this mutual inclination will be found the same in any two opposite terminal planes of any other crystal of quartz.

Nor does it make any difference in this respect, whether the sides of the crystal are symmetrically formed, or whether one side and terminal plane are enlarged at the expense of the others, or not. Thus, in fig. 56, although



one of the lateral and terminal planes are extended, while the others have suffered a corresponding diminution, still the angles at  $a$ , and  $a$ , as well as that at  $o$ , have the same quantities as those on the similar parts of fig. 55.

This system of order and regularity, in respect to angular admeasurements, prevails in all perfectly crystallized bodies of every kind.

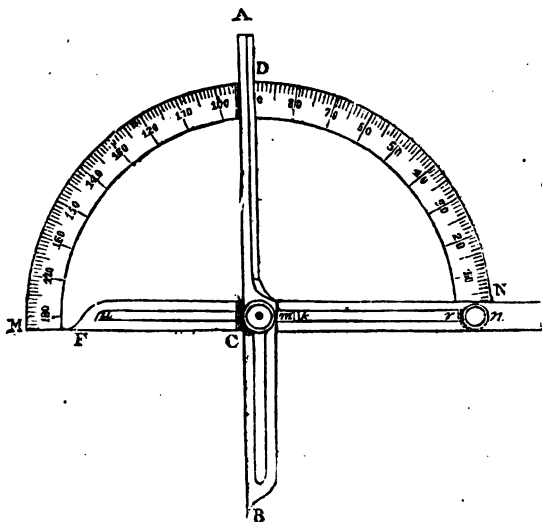
[For questions, vide page 38.]



## GONIOMETER.

The *goniometer*, or angle measurer, is an instrument by which the angles of crystals are determined. The instrument here figured is called the *common goniometer*, in order to distinguish it from the *reflective goniometer*, an instrument not so easily employed, though more accurate in skilful hands.

Fig. 57.



The common goniometer consists of a brass semicircle, M, N, graduated into 180 degrees. B, and D, are two steel arms connected by a thumb screw so that they can be screwed tighter together when occasion requires. This screw enters a small steel nut on the under side of the bar, connecting the two ends of the semicircle, and is the pivot on which the arms turn. In each arm there is an oblong aperture through which the pivot passes, so that they may be drawn back, the effect of which is to move the centre of motion nearer the pointed

What is said concerning the invariable quantity which the angles of crystals present?—Explain fig. 55, and point out which angles are referred to in the text—When one face of a crystal is larger than another, does this make any difference with respect to the angles?—Compare figures 55 and 56, and show the correspondence of their angular quantities.

What is the goniometer?—Of what does this instrument consist?

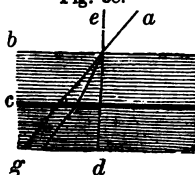
ends of the arms. C, is a short pin passing through an aperture in the under arm so as to keep it in its place.

The most convenient mode of using this instrument is to take off the arms, and for a small crystal, to draw them back on the pivot, so as to bring the centre of motion near the pointed end, and for large ones, let them remain as they now are. Then tighten the thumb screw, so that the arms need not move and lose the true angle. Having applied them carefully to the crystal, put the under arm in its place, as shown in the figure, and the right side of the other arm will cut the degree on the graduated scale.

### DOUBLE REFRACTION.

It is well known that when a ray of light passes obliquely from one medium to another of a different density, it is refracted, or bent out of its original direction. Experiment shows that when the ray passes from a rarer, into a denser medium, it is always refracted *towards* a perpendicular line passing through that medium, and also that when it passes from a denser into a rarer medium, it is refracted in a contrary direction, or *from* such a perpendicular. The air, water, glass, or any other transparent substance employed for such experiments, is called a *medium*. Agreeably to this law, when light passes obliquely from the sun into water, the rays are refracted towards a perpendicular line, raised from the point where the ray meets the medium.

Fig. 58.



Thus, let the medium, *b*, fig. 58, be glass, and the medium, *c*, be water. Then the ray *a*, as it falls from the air upon the medium *b*, will be refracted towards the perpendicular line *e*, *d*; but when it reaches the rarer medium, water, whose refractive power is less than that of glass, it is not bent towards the perpendicular as before, but is thrown *from* it, and approaches the original direction of the ray *a*, *g*, as it passed through the air.

This explains the reason why objects are multiplied when seen through the inclined contiguous surfaces of any transparent medium. The light coming from the object being, refracted by the oblique surface, passes to the eye in a different

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Explain the method of using this instrument.—What is meant by refraction?—When a ray of light passes from a rarer into a denser medium, how is it refracted?—What is a medium?—Which way is a ray of light refracted when it passes into water?—Explain fig. 58, and show how the ray is affected in its passage through water and glass.

direction from that of the real object, and hence as many images are seen as there are oblique planes.

Fig. 59.



This optical law may be well illustrated by any perfectly formed crystal of quartz, fig. 59. The black point seen through the upper lateral plane, appears in the direction in which it really is, because there, the two opposite faces, being parallel, the light is not refracted. But though there is really but one point, or object, there seems to the eye to be four, because the obliquity of the other surfaces bend the rays of light, so as to make the images of the object come to the eye from different directions. The same effect is produced by glass or other transparent substances cut into the same form.

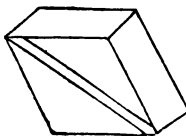
In all these cases, whether the object is seen double, or treble, the phenomena are those of *simple*, or *single* refraction, because the direction of the rays of light are changed only by the direction in which they happen to strike the transparent surfaces.

In the phenomena of *double* refraction, the effect depends on an entirely different cause from that here explained, since the image of a single object is doubled when seen through two parallel surfaces.

The phenomenon of double refraction was first discovered by means of a transparent piece of *rhombic carbonate of lime*, called *Iceland spar*.

To observe it, a transparent crystal with polished surfaces must be selected. If the surfaces are not naturally smooth, they may readily be made so by rubbing on a plane whetstone, and afterwards polishing on a razor strap with a little whiting. Having prepared the crystal, draw a line with ink on paper, and look at it through any of its parallel faces. If the crystal be turned so that its longer diagonal, or acute angles, corres-

Fig. 60.



pond with the line, the greatest refraction will be produced, and the two images will be most distant from each other. Fig. 60 represents a rhombic crystal placed over a black line, in the direction to show this effect.

Explain fig. 59, and show the reason why four images are seen, when there is only one object—Does fig. 59 illustrate single or double refraction?—What is the difference between single and double refraction?—By what means was double refraction discovered?—How may this phenomenon be observed?—In what position of the crystal does the greatest refraction take place?

Fig. 61.

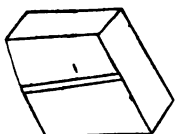
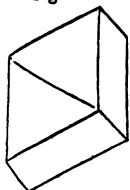


Fig. 62.



If now the crystal be gradually turned, or made to revolve, either to the right or left, the refracted lines will be seen gradually to approach each other, as represented by fig. 61; and if the revolution be continued until the shorter diagonal, or obtuse angles of the crystal correspond with the line, the double refraction will entirely disappear, and only one image will be seen, as in fig. 62. If a second crystal of spar be laid on the first, so that their positions shall correspond with the greatest degree of refraction, the effect will be increased, or doubled, if the crystals are of the same thickness. And if now the upper crystal be made to revolve on the lower one, so as to bring the obtuse angles of the first to coincide with the acute angles of the other, three lines will be observed instead of two, as before. If the revolution be continued so as completely to reverse the angles, and the oblique planes of the two crystals, the doubly refractive effect will cease entirely, and only a single image will be seen. The property of double refraction is possessed by a considerable number of substances. These are chiefly native, and artificial crystals. In some of these, this property cannot be observed, without much practical skill, and in others the crystals require to be cut and polished in a peculiar manner before it can be observed.

In respect to the *cause* of double refraction, it is perhaps only necessary to say here, that it has excited the attention of philosophers ever since its discovery, and that it still remains doubtful.

#### COLOURS OF MINERALS.

This property is exceedingly various, and though one of the most obvious and striking among the external characters of minerals, is not always the most sure means of distinction. In some minerals the colour is accidental, and depends upon the presence of certain metallic oxides. Thus *quartz* may be yellow, brown, red, purple, white, or colourless, and transparent, depending on the presence or absence of certain metallic

In what position is the refraction least?—What is the effect, when a second crystal is laid on the first?—What position of the two crystals produces three lines?—Do other substances besides Iceland spar occasion the same phenomena?—What is said concerning the cause of double refraction?—How far is colour to be depended on as a means of distinguishing minerals?

oxides. The *diamond* also is found either yellowish, blue, rose red, nearly black, or perfectly transparent and without a tinge of colour. In these and many other instances, no reliance, as a means of distinction, can be placed on colour alone. This uncertainty, however, applies chiefly to the earthy and alkaline minerals, there being others in which the colour, arising from some essential part of the composition is invariable, and therefore a sure characteristic. This is especially the case with all the native metals, and with most of the metallic ores. Thus the ores of lead, arsenic, mercury, and many others, may be distinguished merely by their colours.

Mineralogists have assumed eight colours as primary, or fundamental, and then described the shades arising from these. But in addition to colour merely, there is an important distinction, arising from the kind of surface from which the colour is reflected. The shade of colour arising from a metallic surface, differs materially from the same shade when reflected from any other substance. Hence colours have been divided into *metallic*, and *non-metallic*.

*Metallic colours.* These are *copper-red*, the colour of metallic copper. *Bronze yellow*, a little darker than brass. *Brass yellow*, the colour of brass. *Gold yellow*, the colour of pure gold. *Silver white*, the colour of pure silver. *Tin white*, the colour of pure tin. *Lead grey*, the colour of newly cut lead. *Steel grey*, the colour of broken steel. *Iron black*, the colour of black oxide of iron.

*Non-metallic colours.* The eight primary, or fundamental non-metallic colours are, *white*, *grey*, *black*, *blue*, *green*, *yellow*, *red*, and *brown*.

The shades of each of these colours are described by some mineralogists with great minuteness, as snow white, greenish white, milk white, velvet black, bluish black, &c. but this appears to be hardly necessary in an epitome like the present.

*Play of colours.* A few minerals present curious and interesting phenomena with respect to the colour of the light which they reflect. These peculiarities seem to arise from different causes, probably depending on the structure of the mineral. The great beauty and value of the *precious opal*, arises from this peculiarity. As its position is varied with respect to the light, it transmits from its interior, most of the colours of the

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Under what circumstances is colour to be depended on?—In what minerals are the colours invariable and characteristic?—How do mineralogists divide colours?—What are the metallic colours?—What are the non-metallic colours?—What is observed concerning the play of colours?

rainbow, either in succession, or sometimes several at the same instant. Dr. Brewster, after numerous experiments, concludes, that this play of light from the opal is caused by its fissile structure, and not by accidental fractures, as others had supposed.

The *labradorite* or *opalescent felspar* also presents a remarkable play of colours, especially when cut into a convex elliptical shape, and polished. The colours appear to come from immediately under the surface, and not from the interior of the stone as in the opal.

**Iridescence.** This property differs entirely from those described above. It is sometimes evidently caused by accidental fissures in the interior of the stone, and consists in the reflection of prismatic rays from within its surface. Two smooth pieces of glass, pressed together with the fingers, will produce similar phenomena. Rock crystal, or pieces of fractured glass, sometimes display these colours in great beauty.

**Tarnish.** This is a change of colour merely on the surface of the mineral, arising from the different degrees of oxidation it has undergone, and in consequence of which various tints, as green, blue, yellow, &c. are reflected. Such effects are chiefly confined to the metallic ores, and such substances as contain a portion of metal in their composition, or investing their surfaces. *Specular oxide of iron, anthracite coal, and copper pyrites*, often present fine examples of irised surfaces.

#### LUSTRE.

The lustre of a mineral depends on the quantity of light which is reflected from its surface. This is often an important character in distinguishing specimens, because it is uniform in the same species, and not, like colour, liable to variations.

The kinds of lustre are the *metallic, adamantine, resinous, vitreous, and pearly*.

The *metallic* lustre is exemplified in the peculiar appearance of all the metals and many of their ores, when compared with other bodies.

The *adamantine* lustre is not easily described, but is readily distinguished in the diamond, corundum, and carbonate of lead.

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What is the most probable cause of the play of colours in the opal?—What is the cause of iridescence?—How is this illustrated with two pieces of glass?—What is meant by tarnish?—What minerals are liable to this change?—On what does the lustre of a mineral depend?—What are the kinds of lustre mentioned?—What minerals show the adamantine lustre?

The *resinous* lustre is that of broken resin. Examples of this lustre occur in pitchstone, and vesuvian.

The *vitreous* lustre is that of fractured glass. Quartz, topaz, and beryl, are examples.

The *pearly* lustre is that exhibited by the mother of pearl. Some minerals show this lustre only when they reflect the light in a certain direction.

#### HARDNESS.

This is a character of considerable importance, since it is generally uniform in the same variety. It is that property by which substances resist impressions and is ascertained by comparing one mineral with another. Minerals are compared in this respect by scratching one with another, or by making a few, well known species, the standards of comparison. Quartz is one of these standards. Thus if any mineral is found to scratch quartz, it is considered as being harder than that substance, as topaz, sapphire, &c. Glass has also been made a standard for the same purpose. All the varieties of quartz scratch glass, while all the carbonaceous minerals are softer than glass, and may be generally scratched by the point of a knife. This is often a highly convenient mode of distinguishing the silicious, from the limestone species. Minerals of a lower degree of hardness than such as *yield to the knife*, are such as *yield to the nail*. For this purpose the thumb nail is used. Gypsum, talc, and the clays are examples.

#### ELECTRICITY.

Some minerals become electric by *friction*, others by *pressure*, and others by *heat*.

There are two kinds of electricity, called *positive* and *negative* by some, and by others *vitreous* and *resinous*. When two substances, possessing the same kind of electricity, are brought together, they mutually repel each other. If one is positive and the other negative, they attract each other.

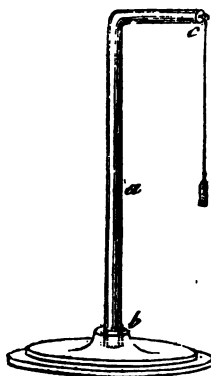
*Quartz, mica, sapphire, barytes*, and many other minerals, acquire electricity when rubbed with the dry hand, or with a

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What is the appearance of the *resinous* lustre?—What is the best example of the *vitreous* lustre?—What is the *pearly* lustre?—What is hardness?—How is the hardness of minerals ascertained?—What substances are taken as the standards of hardness?—How is it ascertained that one mineral is harder than another?—What are the two kinds of electricity called?—When do two electrical substances repel each other?—When do they attract each other?—By what different processes *minerals become electric*?

piece of silk, woollen cloth, or fur. These are said to become electric by friction. Those which become electric by heat are called pyro-electric. These are chiefly crystals, and it is a curious circumstance that they acquire positive electricity at one end, and negative at the other. Such crystals often terminate in a different number of faces at each extremity, and it is remarkable that the end having the greatest number of faces is always positive. Perfect crystals of *tourmaline*, or *schorl*, display this property in the most striking manner.

Fig. 63.



The electricity of minerals is shown by a little instrument called an *electrometer*, fig. 63. It consists of a glass stem, *a*, which is fixed in a small wooden base, *b*, and to the upper end, *c*, there is suspended a small piece of gilt paper by a silk thread. To try the electricity of a crystal of *tourmaline*, hold the mineral in a pair of forceps with a glass handle, for a minute, over a lamp to heat it, and then present it towards the gilt paper. The paper will be attracted and move forward to meet the crystal; then on presenting the other end of the crystal, the paper will be repelled, and retire from it, showing that one end is positive and the other negative. The forceps with the glass handle are necessary in these experiments, because the hand would conduct away the electricity if it touched the mineral, whereas the glass is a non-conductor of the electrical fluid.

Quartz, and other minerals which become electric by friction, must be rubbed on a piece of fur, or other soft non-conducting substance, and then presented to the gilt paper.

In most instances, *polished* stones acquire positive electricity by friction, while if the same stones have their polish destroyed, they acquire negative electricity, by the same treatment. The diamond, however, is an exception to this, being always positive, whether rough or smooth.

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What is said of the different electricities acquired by the extremities of some crystals?—Describe the electrometer, fig. 63, and the mode of using it—Why is it necessary to use forceps with glass handles in these experiments?—Which electricity do polished stones acquire by friction?



## PHOSPHORESCENCE.

A body is said to phosphoresce when it gives light without heat, or when it shines by being heated below redness.

This property is not constant, even in the same species. Thus some varieties of fluuate of lime become beautifully phosphorescent, when thrown on an iron shovel heated below redness, while other varieties, when treated in the same manner, yield no perceptible light.

Some minerals exhibit this property when scratched, or rubbed against each other, and a few, even when brushed with a feather. Two pieces of quartz, when struck against each other in the dark, will emit a faint flash of light. And that variety of carbonate of lime called *dolomite*, when scratched with the point of a knife, in the dark, emits a streak of light. *Blende*, or sulphuret of zinc, exhibits the same property. The best way to show the phosphorescence of fluor, colophonite, argentine, and other minerals requiring heat, is to make a shovel red hot, and having immediately carried it into the dark, sprinkle on the mineral in the state of coarse powder. As the iron cools and turns black, the phosphorescent light will be seen.

## SPECIFIC GRAVITY.

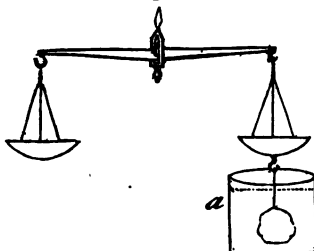
The specific gravity of a body is its weight when compared with the weight of a quantity of water equal to its own bulk. Thus when we say that gold has a specific gravity of 19, we mean that gold is 19 times as heavy as a quantity of water equal to its own bulk. When a mineral is suspended in water and weighed, it is lighter than when weighed in air, by the weight of a quantity of water equal to the bulk of the mineral so suspended. The reason of this is obvious, for if the substance was not, bulk for bulk, heavier than water, it would not sink in it, but if it sinks, its weight must be diminished by exactly that of the quantity of water it displaces.

To find the specific gravity of a substance, therefore, it must first be weighed in air, or in the ordinary manner, and then weighed in water, when its specific gravity may be found "*by dividing its weight in air by its loss in water.*"

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When is a body said to phosphoresce?—By what means are minerals made to exhibit this property?—What is the method of showing this property in minerals requiring heat?—What is the specific gravity of a body?—Why is the specific gravity of gold said to be 19?—Why does a mineral weigh less in water than in air?—What is the rule for finding the specific gravity?

Fig. 64.



First weigh the body in a delicate pair of scales, and note down its weight in grains. Then with a hair, or fine thread, suspend it from the bottom of the scale-dish in a vessel of water, as represented by fig. 64. As it weighs less in water, weights must be added to the side of the scales where the body is suspended, until they exactly balance as at first. Next note down the number of grains so added, and they will show the difference between the weight of the body in air and in water. Now it is plain that the greater the specific gravity of the body is, the less comparatively will be this difference, because each body displaces only its own bulk of water, and some bodies of the same size, are many times more heavy than others. Thus a square inch of platina will weigh 22 ounces, while the same bulk of silver will weigh only 11 ounces. But the two pieces of metal when weighed in water will loose exactly the same number of grains, because they each displace a square inch of water, though in comparison to their weights, the platina only loses just half as much as the silver, because it weighs twice as much. This is the principle on which the rule is founded, for the greater the loss is, the less in proportion will be the specific gravity, and so the contrary.

Having noted down the weight of the mineral in air, and its loss in water, divide the number of grains representing the first, by that representing the last, and the answer will give the specific gravity. Thus suppose 22 ounces of platina to lose 1 ounce, 11 ounces of silver to lose 1 ounce, then 22 being divided by 1, gives 22, and 11 being divided by 1, gives 11. The specific gravity of platina is therefore 22, while that of silver is 11.

#### CHEMICAL CHARACTERS.

We have now enumerated the principal characters of minerals which can be ascertained without chemical re-agents. These are called their *external*, or *physical* characters.

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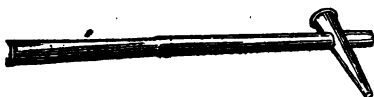
Describe the method of taking the specific gravity of a body by the scales, fig. 64.—Why does a square inch of platina lose a less proportion of its weight in the water than the silver?—What are the external or physical characters of minerals?

There is still another class of characters which are employed in distinguishing minerals. These are called *chemical* characters, because heat and acids are the agents by which they are detected. These characters are developed by means of the mouth *blow pipe*, and a few simple experiments made by means of two or three acids.

The blow pipe is a very simple instrument, but in skilful hands is of great power, and to the mineralogist is indispensable, as well as highly convenient.

It most commonly consists of a slightly conical, or tapering tube of brass, 10 or 12 inches long, curved towards the small end, and terminating in a fine orifice. A more convenient form, however, is that represented by fig. 65. This consists of three pieces, as

Fig. 65.



shown by the figure, which are made to fit each other accurately by grinding.

For the convenience of transportation, the smaller long piece, when the instrument is taken apart, fits into the larger, and into this, the tip is put as a stopper. Thus the instrument assumes a very small compass, and may be carried in the pocket.

This instrument is used by taking the large end into the mouth, placing the small end in the flame of a lamp, and gently blowing, so as to direct the flame on the mineral, which is laid on a charcoal support.

To keep up a constant stream of air, is the chief difficulty which the beginner will experience in the use of this instrument. To do this, the inspiration must be made through the nostrils, while the cheeks are employed as bellows. This art is however soon learned by practice. A small pair of forceps are used to hold the charcoal, on which the fragment of ore is laid. When a very intense heat is required, and the fragment is so light as to be in danger of being blown away by the air, it may be confined by making a small cavity in the charcoal, into which the substance is put, and partly covered by another piece of charcoal.

By means of this simple instrument, the most violent heat of a furnace may be produced, while the experimenter has

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What others, besides physical characters, are employed in distinguishing minerals?—By what means are the chemical characters of minerals developed?—Describe the blow pipe represented by fig. 65—What is the method of using this blow pipe?—What are the advantages of the blow pipe in making experiments on minerals?

the advantage of constantly seeing how his specimen is affected by the heat ; when it is melted ; what odour arises from it, &c. In refractory minerals, the fragment should not exceed the size of a grain, or even half a grain of wheat.

In respect to the intensity of the heat, there is a considerable difference, depending on the kind of fuel employed for this little furnace. The flame from a tallow candle is better than that from oil, and wax makes a stronger heat than tallow.

In making experiments with the blow pipe on the metallic ores, *fluxes* are used, and it is often the case that the best test of the presence of certain metals, or metallic oxides, is the colour imparted to the flux. One of the most common and convenient fluxes for the purpose, is glass of borax, or common borax, deprived of its water of crystallization by heat. This will not spread on the charcoal, nor sink into it, but when melted always takes the form of a globule. The mineral and the borax should be in the state of powder, and made into the form of a little ball with a drop of water. This being laid on the charcoal, the heat should be gradually applied until the borax is melted, when it may be raised to the utmost.

*Action of the acids.* The acids are employed in practical mineralogy, merely as tests, to distinguish certain minerals from each other. Thus carbonate of lime may generally be distinguished by its effervescence, as we have already seen. Certain minerals form a jelly with acids, and are thus known from others which they most resemble, and which have not this particular property.

In making experiments with the acids, one of the most convenient vessels is a watch crystal, in which a little of the acid being placed, the mineral is dropped in, in the state of powder, from the point of a knife. Some minerals, on which the acid will produce little or no observable effect in the mass, will effervesce smartly in the state of powder. The acids employed are the sulphuric, nitric, and muriatic.

#### CHEMICAL MINERALOGY.

In systematic books on mineralogy, the minerals are ar-

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What should be the size of the fragment experimented on ?—Does it make any difference what kind of fuel is employed for the blow pipe ?—What is said of the use of fluxes ?—What is the most common and convenient flux ?—How is this flux to be used ?—For what purpose are the acids employed in mineralogy ?—What is said to be one of the most convenient vessels in making experiments on the minerals with acids ?

ranged according to their chemical composition, and not according to their colours, or external forms. When the crystalline form is precisely the same, it will be obvious, from what has already been stated, that the mineral belongs to the same individual species. But two minerals may have nearly the same form, and still differ entirely in their compositions. Thus one *variety of carbonate of lime*, and one of *carbonate of iron*, so nearly resemble each other in their crystalline forms, that the eye can distinguish no difference, and it is only by the use of the goniometer that any variation in the quantities of their angles can be determined.

Now although the crystals resemble each other so nearly in external appearance, it is apparent that they cannot with any propriety be classed together, because they differ so essentially in their qualities.

On the contrary, some minerals, although composed of nearly the same ingredients, differ entirely in external form, colour, fracture, and lustre. Thus quartz is sometimes colourless and transparent, and in the form of a perfectly symmetrical solid, and sometimes it is red, yellow, purple, or brown, the form continuing the same. Other specimens of quartz are amorphous, that is, without any regular form, and these present a great variety of colours, fracture, lustre, and texture. Still all these varieties are essentially composed of the same constituent, *silex*, the only difference being, that one variety contains a small portion of the oxide of some metal, on which its colour depends, which the other wants.

The place of every mineral in the arrangement being determined by its essential qualities, it is obvious that a resemblance of colour or form, constitutes a difference which may be only accidental, and that the only sure method of arrangement must depend on the composition of each individual species. Thus when we find, on chemical analysis, that a number of minerals are composed almost entirely of quartz, or *silex*, though they differ in colour, form, transparency, and other external characters, still in the most essential property, that is, composition, they closely resemble each other, and therefore ought to be arranged together. For the same reason, all the varieties of *carbonate of lime*, though they differ

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How are minerals arranged in systematic books?—Does the near resemblance of crystalline forms, indicate a similarity of composition?—Do minerals of the same essential composition often differ much from each other in fracture, form, and colour?—Why is the chemical method of arrangement the only sure one?

from each other in almost every external respect, still agree in the essential property of composition, and therefore are arranged accordingly.

The composition of minerals is determined by chemical analysis, which consists in separating each ingredient, or element, of which the substance is composed, from the others, so that each may be tested, and weighed, or otherwise examined by itself. These processes, where the mineral is composed of many elementary substances, are long and difficult, requiring great skill and much practical knowledge of chemistry.

The principal substances of which minerals are composed, besides the metals, are what were formerly known under the general name of the *earths*. These substances are now some of them considered metallic oxides, or metals forming earths, when united to oxygen, in which state they naturally exist. They are lime, barytes, strontites, magnesia, silice, alumine, itria, glucina, zirconia, and thorina.

Of these it is not certain that any are composed of a metal and oxygen, except the four first named, though by analogy, the metallic nature of the others is inferred.

Besides these earths, mineral substances contain three alkalies, called potash, soda, and lithia. The basis of potash is a metal of a silver white colour, and so light as to swim on water. It is called *potassium*. The basis of soda is also a metal similar in its appearance and properties to potassium. It is called *sodium*. When potassium is exposed to the air, it absorbs oxygen from the atmosphere, or burns, and is thereby converted into the well known substance, *potash*. By a similar process, sodium is converted into soda. These circumstances are a sufficient proof that the bases of potash and soda are metals. The basis of the other alkali, lithia, is also of a metallic nature, and is called *lithium*. The metallic bases of the earths and alkalies are called *metalloids*, to distinguish them from the other, or more perfect metals.

Some of the earths above enumerated form the principal parts of a great number of minerals, while others have only

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How is the composition of minerals determined?—In what does analysis consist?—Is the analysis of minerals, a simple, or a laborious and complicated process?—What are the principal substances of which minerals are composed, besides the metals?—What are the names of the earths? Which of these are metallic oxides?—What three alkalies are found in minerals?—What is the metallic base of potash called?—What is the metallic base of soda called?—By what general term are the metallic bases of these substances known?

been found in a few rare specimens. The most common and abundant earths are lime and silex. These form the chief bulk of the mountains in all parts of the world. Alumine, which is the base of clay, is also very abundant. On the contrary, *zirconia* has only been found in two precious stones, *zircon*, and *hyacinth*; and *glucina*, *ittria*, and *thorina*, have each been detected but in a few instances, and only in minute quantities.

The number of metals known, besides the metalloids, are 29. Their names are as follows:—platinum, gold, silver, palladium, rhodium, iridium, osmium, mercury, nickel, columbium, tungsten, chromium, molybdenum, arsenic, tellurium, selenium, cerium, titanium, uranium, cobalt, bismuth, antimony, lead, copper, cadmium, tin, zinc, iron, manganese. The metals are all simple, or elementary bodies, that is, they cannot be decomposed or separated into more simple elements, or parts.

Including the metalloids, there are forty metals in the whole, all elementary bodies, found in the earth. Besides these, chemists enumerate ten or eleven other simple substances. These are the gases, *oxygen*, *chlorine*, *hydrogen*, and *nitrogen*, and the solids, *iodine*, *sulphur*, *phosphorus*, *carbon*, and *borax*, which is the basis of borax, and *bromine*, which is a substance newly discovered in sea water, resembling iodine in its properties.

The whole number of simple, or individual substances, therefore, which compose all that variety of rocks, stones, metals, and earths, found under the surface of the globe, as well as all the trees and vegetables which grow on it, and all the men and animals which inhabit it, including all kinds of fish and shells that live in the sea, amount to only fifty, or fifty-one. This is a striking illustration of the wisdom and power of the Creator; for who beside Him “who brought all things out of nothing,” could have made such an endless variety of forms, colours, and modes of existence, out of such simple means.

Many of these substances are common to the three kingdoms, of nature, the animal, the vegetable, and the mineral. Thus oxygen, nitrogen, hydrogen, phosphorus, sulphur, and carbon, are

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Which are the most common and abundant earths?—What is said of the other earths?—What number of metals are known, exclusive of the metalloids?—Are the metals simple, or compound bodies?—Including the metalloids, what is the number of metals?—What other elementary bodies are there, besides the metals?—What is the whole number of simple substances of which the crust of the earth is composed, including all the objects existing thereon?—What elements are found in the three kingdoms of nature?

found combined with other substances, in animals, vegetables, and minerals. All the other simple substances, with the exception of chlorine, may be considered as peculiar to the earth and sea, though iron and perhaps one or two of the other metals, are formed in minute quantities, in animal and vegetable bodies. *Chlorine* is an artificial gas, obtained by mixing together common salt, black oxide of manganese, and sulphuric acid, and never has been discovered as a natural substance. *Oxygen* and *hydrogen* exist in a state of combination in vast abundance, since they are the elements which form water. *Nitrogen* also exists in abundance, since it forms four fifths of the atmosphere which we breathe, the other fifth being oxygen. Nitrogen also forms a considerable proportion of all animal substances, and is found in nitre, or nitrate of potash, and in certain vegetables. *Phosphorus* composes a part of certain minerals called *phosphates*, as phosphate of lime, and phosphate of iron. *Sulphur* is a constituent in a great proportion of mineral compounds. These are called *sulphurets*. About one half of the metals are found combined with sulphur, forming the sulphurets, of silver, of lead, or iron, &c. Sulphur is also found in large quantities in the vicinity of volcanoes, being sublimed or brought up by the heat from the interior of the earth, probably by the decomposition of the metallic sulphurets.

Carbon is found in abundance in the earth, being the chief element in the composition of coal. It is also found combined with iron, forming a *carburet* of that metal. The diamond is composed entirely of carbon. *Iodine* is contained in sea water, and in the waters of several springs. Boron is the basis of *boracic acid*, which is a part of the composition of the well known substance called *borax*.

All the metals, except platina and gold, are found *mineralized*, or in the state of ores. Many of them are also found in the native or metallic state. This is the case with *silver*, *bismuth*, *copper*, *antimony*, *arsenic*, *iron*, *nickel*, *palladium*, and *quicksilver*. All these metals, with perhaps the exception of bismuth, are however much more frequently found in the state of ores, than in their native, or metallic state.

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Is chlorine a natural, or an artificial gas?—In what natural substance does oxygen and hydrogen exist in abundance?—What is the composition of the atmosphere?—Where is phosphorus found?—Where is sulphur found?—What mineral substance is composed chiefly of carbon?—What is the diamond composed of?—Where is iodine found?—What is the basis of boracic acid?—Which of the metals are never found mineralized?



*Gold and platina*, though never found mineralized, or in the state of ores, seldom occur perfectly pure. Gold exists in its native state, alloyed, or mixed with silver, copper, iron, and several other metals. And platina always contains the metals *osmium*, *iridium*, iron, and often several others.

Some of the metals are mineralized by only one or two substances, while others are found combined with several. Thus mercury is chiefly mineralized by sulphur, and is never found in combination with oxygen, carbon, or any of the mineral acids, except the muriatic. Its ores are therefore few in number, and rarely found. Iron, on the contrary, is capable of very numerous combinations, being mineralized by oxygen, sulphur, carbon, phosphorus, carbonic acid, and many other substances. Its ores are consequently very numerous and exist in nearly every section of country.

*Copper and lead* are also widely disseminated, and are each found in combination with a variety of mineralizing substances.

We come now to the classification and description of Minerals, the object of which is, to distinguish them from each other. At the head of each class the elements, or ingredients which chiefly compose the species, are enumerated. The particular composition of each species, when important, is given with the description.

## CLASS I.

### ACIDIFEROUS EARTHY MINERALS.

Under this head are included such minerals as consist of an earth combined with an acid; some of them contain small portions of metal, as iron, manganese, and perhaps chrome, &c.

#### LIME.

This earth has never been found pure except in small quantities. For the most part it is found combined with carbonic acid, forming *carbonate of lime*; it also occurs combined with sulphuric acid, forming *sulphate of lime*, or gypsum; with phosphoric acid, forming *phosphate of lime*; and with several other substances.

Pure lime is white, hot to the taste, corrosive to the touch, and capable, when water is thrown on it by degrees, of consolidating it, and extricating a degree of heat which sets wood on fire; it destroys animal and vegetable substances, and it turns vegetable blues to green.

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Are gold and platina found perfectly pure?—By what substances is mercury mineralized?—By what substances is iron mineralized?—Is lime ever found in its pure state?—With what other substances is lime principally found combined?

The compounds of lime are so abundant in nature, that geologists have estimated one fourth of the crust of the globe to be formed of them.

*Species 1. CARBONATE OF LIME.*

This species includes a great variety of calcareous minerals, many of which differ widely from each other in their external characters. Some varieties occur in the form of crystals, of which there is an immense number of secondary modifications; some varieties are compact, some are pulverulent, some are granular. The colours which the varieties of this species assume, are so various, as to include nearly the whole catalogue; the prevailing colour, however, is white, or greyish white.

*Chemical characters.* Infusible, but becomes caustic or quicklime before the blowpipe; effervesces with acids.

*Composition.* Lime 57; carbonic acid 43.—*Klaproth.*

*Variety 1. CALCAREOUS SPAR.*

*External characters.* Colours, various, generally white, yellowish or grey, often red, &c. occurs crystallized; forms extremely numerous, amounting to upwards of 500 secondary varieties, all originating from an obtuse rhomboid, the alternate angles of which are  $105^{\circ} 5'$ , and  $74^{\circ} 55'$ ; fragments rhomboidal; lustre, more or less shining, often pearly; fracture uneven, but difficult to be obtained on account of the ease with which it separates at the natural joints; cleavage in direction of the natural joints, very easy and perfect, displaying smooth polished faces, transparent or translucent; the transparent, particularly that from Iceland, doubly refractive; often occurs in hemitrope, or macled crystals; yields to the knife: sp. gr. 2.72.

Only a few of the most common forms can be illustrated by figures.

Fig. 66.

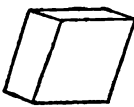


Fig. 67.



Fig. 68.

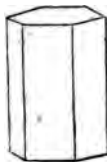


Fig. 69.

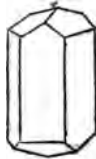


Fig. 70.



What are the chemical characters of carbonate of lime?—What are the colours of carbonate of lime?—What is the primitive form of carbonate of lime?

Fig. 66. The primitive rhomboidal prism.

Fig. 67. The acute rhomboid.

Fig. 68. A six-sided prism.

Fig. 69. A hexahedral prism with pentagonal sides, and terminated by pentagonal faces.

Fig. 70. A dodecahedron, composed of two six-sided pyramids joined base to base ; each face being a scalene triangle. This variety at first view appears as two triangular pyramids, but on closer inspection, each of the three larger sides will be found to contain two scalene triangular faces. These crystals are commonly grouped, so that only one of the pyramids appear distinct. It is a common variety and bears the name of *hog-tooth spar*.

Fig. 71.



Fig. 72.



Fig. 71. The double six-sided pyramid, with the summits truncated, and an outline of the primitive form in the centre.

Fig. 72. The same with truncated summits and solid angles.

Its localities are exceedingly numerous. Fine crystals of some of its varieties being found in almost every limestone country. A considerable variety of beautiful specimens are found at Lockport, N. Y.

Phillips says the rarest and most beautiful crystals are found at Derbyshire, and the northern parts of England.

*Distinctive characters.* From the carbonates of lead, strontian and barytes ; and also from the sulphates of barytes and strontian ; it may be distinguished by its burning to quicklime : sulphate of lime does not effervesce with acids.

#### *Variety 2. ARGENTINE.*

*External characters.* Colors, milk white, reddish or greyish white ; lustre pearly ; occurs in thin tabular plates, gene-

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What is the shape of that variety called *hog-tooth spar* ?—What are the distinctive characters of this mineral ?—What is the colour and composition of *argentine* ?

rally curved, or undulated; translucent, or nearly opaque; structure of the massive, slaty, presenting curved shining layers; yields to the knife; easily broken; phosphorescent on hot coals.

*Chemical characters.* Infusible, but decrepitates and separates into thin plates, and finally becomes caustic quicklime. Effervesces with acids.

*Composition.* Lime 56; carbonic acid 39.33; siliceous oxide of iron 1; water 2.—*Klaproth*.

It is found in primitive rocks.

*Localities.* Saxony, Norway, Cornwall, Granard in Ireland, &c.

U. S. Southampton lead mine, Mass.

#### *Variety 3. SATIN SPAR.*

*External characters.* Colour, yellowish white, white or pale red; occurs massive, consisting of fine delicate fibres adhering closely together; lustre, that of satin; bears a fine polish; often chatoyant; translucent.

*Composition.* Lime 50.8; carbonic acid 47.6.—*Pepys*.

*Localities.* The finest specimens are from Cumberland, Eng.

U. S. near Baltimore, Md.; Cumberland Valley, Pa.; Newburyport, Mass.

Satin spar when polished is a very beautiful mineral. It is used for inlaying, and for the manufacture of ornaments, as necklaces, ear rings, &c. instead of pearl. It is now a scarce mineral.

#### *Variety 4. AGARIC MINERAL. ROCK MILK.*

*External characters.* Colour, yellowish or greyish white; occurs in soft earthy masses, composed of particles slightly cohering; soils the fingers; opaque; tender; spongy; for a moment swims on water; effervesces with acids.

*Composition.* Nearly pure carbonate of lime.

It is disintegrated marble.

It is found in veins, in calcareous rocks.

#### *Variety 5. APHRITE.\* EARTH FOAM.*

*External characters.* Colour white; occurs in masses, composed of scales, of a shining pearly lustre; opaque; soft to the touch.

\* From the Greek; a foam-like substance.

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What is the appearance of satin spar?—What is the use of satin spar?

It is found in cavities, or veins in calcareous rocks.

*Subspecies 1. STALACTICAL CARBONATE OF LIME.*

*External characters.* Colours various, mostly white or yellowish white, or grey; occurs in concretions, stalactical, botryoidal; mammellated and in long pendulous concretions, like icicles; lustre pearly, or silky.

*Variety 1. STALACTITE.*

It occurs in long straight pendulous masses, or hollow tubes; or in larger tuberose, irregular masses, with a rough, warty surface; sometimes several round pieces are joined together, making irregular flattened masses; fracture fibrous, often radiating from the centre of the mass; translucent.

Stalactites are found attached to the roofs of caverns in limestone countries, where they are continually forming.

*How formed.* The water percolates through the limestone rocks where it becomes impregnated with calcareous particles. On exposure to the air of the cavern, the water evaporates, leaving the particles of limestone, which adhere, become solid, or form hollow tubes, probably according to the nature of the surface where the stalactite begins to form.

Sometimes the branch of a tree, which happens to be in a proper situation, serves as a nucleus for the stalactite, and becomes incrustated with the limestone, the wood remaining perfectly preserved.

*Variety 2. STALAGMITE. ALABASTER.*

Colour white or yellowish, commonly arranged in undulated lines, or in concentric circles; structure foliated, fibrous, or compact; translucent.

The water which drops from the forming *stalactites*, or trickles down from the roof, or the sides of the cavern, forms the *stalagmite* on its floor. Sometimes the stalactite and the stalagmite meet, forming pillars which rest on the floor, and support the roof. These deposits sometimes fill large caverns, producing imitative forms, as of altars, pillars, and with the help of the imagination, of animals, priests in their robes, &c.

*Uses.* When the stalagmite is compact, of a good colour, and translucent, it is employed in the manufacture of ornamental and useful articles under the name of *alabaster*. Of this, candlesticks, vases, the frames of time-pieces, boxes, &c. are made.

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What is stalactite?—How is stalactite formed?—How is stalagmite formed?—What is the difference between stalactite and stalagmite?—What are the uses of these two minerals?

Compact gypsum is also worked into articles of ornament and use, and called alabaster. The two kinds are easily distinguished by a drop of sulphuric or nitric acid, which will cause an effervescence on the stalagmite, but not on the gypsum. The stalagmite is also harder than the gypsum.

*Localities.* One of the most famous localities is the grotto of Antiparos; another is Woodman's cave in the Hartz; several localities exist in Derbyshire, &c.

U. S. Madison's cave, on the north side of the Blue Ridge, and Wier's cave, both in Va.

#### *Subspecies 2.* GRANULAR LIMESTONE.

*External characters.* Colours, white, grey, yellowish, bluish grey, reddish, greenish; sometimes these colours run in stripes, spots, or clouds; occurs massive, composed of minute grains, or crystals of a lamellar structure, and brilliant lustre; fracture splintery, or slaty; translucent.

Some specimens very nearly resemble *loaf sugar*, both in texture and colour.

It never contains organic remains, as shells, but frequently encloses quartz, garnets, mica, talc, &c. Hence it is a primitive rock.

Primitive limestone forms immense mountains, in many parts of the globe. A considerable proportion of the great chain in Northern Asia, reaching from the Uralian mountains to the river Amur, an extent of more than 1000 leagues, is of this kind of rock. The Pyrennees are also in part formed of primitive limestone, and in the Alps large beds of primitive marble are found.—*Pinkerton*.

*Localities.* These are so numerous that only such as are quarried can be given.

*Statuary marble.* The finest and most perfect kinds of primitive limestone, have, from time immemorial, been employed in architectural decorations, and in statuary. Hence it is commonly called statuary marble.

*Egyptian marble.* Colours milk-white, with silvery scales of mica; also, greyish white, passing into blue; but the most beautiful is black. The red marble of Upper Egypt, called the *rosso antico*, of which the Indian Bacchus is made, and other exquisite remains, is said to surpass in beauty all other marbles.

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What are the colours of granular limestone?—How is it known that this is a primitive rock?—What is statuary marble?—What is said the red marble of Upper Egypt?

*Parian marble.* This was employed by the most ancient Greek sculptors; but being yellowish and coarse grained, it was supplanted by that of Etruria, and afterwards by that of Carrara.

The Venus de Medici, Diana hunting, and Venus leaving the bath, are of Parian marble.

*Pentelican marble.* This comes from the vicinity of Athens. It is white, with black crystals of hornblende, and occasionally green veins of talc. Of this, some of the noblest Grecian monuments are constructed. A Bacchus in repose, a Jason, a Paris, &c. of this marble, remain at Paris.

*Translucent marble.* At Venice, and in the different towns of Lombardy, are columns of marble so translucent that the light of a candle is visible through pretty thick masses.

*Elastic marble.* Tables of ancient elastic marble are still extant at Rome. Pinkerton supposes that this quality may be imparted by certain modifications of heat. Prof. Cleveland states that flexible marble is found at Pittsford, Vt. and at Pittsfield, Mass. and that according to the experiments of Dr. Meade, it loses this property on being heated, but regains it on being plunged into water.

The foreign specimens of this kind which I have seen are opaque, and without polish, resembling fine sandstone.

*Luni marble. Carrara marble.* These two kinds come from adjacent localities. That of Luni is pure white, and is preferred to that of Carrara, which is often stained with veins of grey.

The quarry of Luni is said to have been opened in the time of Julius Cæsar.

*Laconian marble. Verde antico.* This came from Mount Tagetus, in Liconia, and is among the most celebrated and ancient marbles. It is described as being of a most cheerful green, like that of tender herbs or grass, variegated with veins of a glassy white, winding in a spiral manner.—*Pinkerton's Petrology.*

*American marbles.* The United States afford many varieties of primitive marble, several of which have been quarried for useful and ornamental purposes.

*Philadelphia marble.* Colour white, or greyish white, sometimes variegated with veins or clouds, of blue. It receives a fine polish, and is extensively employed.

*Potomac marble.* This is a breccia, and is composed of

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What is said of Parian marble?—What is said of elastic marble?—What are the principal localities of American marble.

rounded and angular fragments from the size of a pea to that of an ostrich's egg. Colours red, white, grey, and blackish brown intermixed, so as to give the whole a highly variegated aspect. It bears a fine polish and is a singularly beautiful marble. Of this marble are formed the shafts of the columns in the chamber of Representatives at Washington. They are about twenty feet high, and two feet in diameter. The locality of this marble is about fifty miles above Washington, on the banks of the Potomac, in Md.—*See Cleveland.*

*New-Haven marble.* Predominant colour, grey, or bluish grey, richly variegated with veins, or clouds of white, green, or black; some specimens are clouded with yellow, or orange; in others the prevailing colour is green with black clouds of chromate, and magnetic oxide of iron. The principal quarry is seven miles from New-Haven, Ct. Prof. Silliman observes, that when this marble contains the green colours, it belongs to the variety usually called *verde antique*. Chimney-pieces of this marble, of which there are four in the capital at Washington, cost from \$250 to \$500 each.

*Vermont marbles.* The state of Vermont affords several beautiful marbles, viz.

*Middlebury marble.* Prevailing colour, grey, running into dark brown of different shades. Some specimens are pure white. This marble receives a fine polish, and is sawn for tomb-stones, chimney-pieces, &c. Professor Hall states, that during the years 1809 and 10, 20,000 feet of slabs were cut by one mill, containing sixty-five saws, and that the sale of marble during the same period amounted to about 11,000 dollars in value.

Quarries have also been opened at Pittsford, Shaftsbury, and Scranton, in Vt.—*Cleveland.*

Massachusetts affords several quarries of Marble.

Professor Dewey states that the annual value of the marble quarried in Berkshire county alone, amounts to more than 40,000 dollars. The localities in this state are Lanesborough; the colour is white and brownish. Stockbridge; colour white, or clouded with dark shades. Sheffield; colour white, or clouded with dark shades.—*Robinson.*

*Thomaston marble.* Colours, white or greyish white, diversified with veins of a different colour. In the finest pieces, the predominant colour is grey, or bluish grey, interspersed by whitish clouds. It is a rich and beautiful marble, receives a fine polish, and is well fitted for ornamental purposes. Three mills, containing in all 150 saws, are employed in saw-



ing and polishing the marble. The price of the best slabs is two dollars a square foot, and about 12,000 feet are annually sold.—*Cleveland.*

### *Subspecies 3. COMMON LIMESTONE.*

*External characters.* Colours white, yellowish white, grey, brown, reddish, bluish, black, &c. ; occurs compact, sometimes granular ; fracture large conchoidal or splintery, sometimes earthy ; lustre dull, or glimmering ; sometimes it is variegated or striped of different colours ; translucent on the edges, or opaque. Sp. gr. 2.6 ; yields to the knife.

*Chemical characters.* It burns to quicklime and effervesces with acids.

*Composition.* It is an impure carbonate of lime, and generally contains portions of silex, alumine, or oxide of iron.

It is sometimes difficult to distinguish secondary or compact limestone from primitive marble, without referring to its locality. In fact, common limestone runs into marl on the one side, and primitive marble on the other.

Secondary limestone of the oldest formation contains oxide of iron, sulphuret of lead, manganese, sulphuret of zinc, &c. but generally no organic remains.

The newer formations are *conchitic*, or contain shells. Pinkerton says that some of the most compact varieties of marble are of this kind.

It is understood that conchitic limestone is of course of secondary formation. But it is not true that every secondary limestone contains shells.

Secondary limestone is sometimes granular, but perhaps only when it is passing into the primitive kind.

*Uses.* When burnt it furnishes quicklime, which, when slacked and mixed with a portion of sand, forms mortar, an article of indispensable use in building, plastering the walls of houses, &c. It is also employed extensively as a building stone, and some of the most beautiful marbles belong to this species.

### CONCHITIC, OR SECONDARY MARBLES.

Pinkerton, in his *Petrology*, has enumerated a great variety of conchitic marbles. From him we shall extract an account of some of the most singular and beautiful.

*Lumachella Marble.* Colour, grey or brown ; often deep

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What are the principal colours of common limestone ?—What is its composition ?—What is the principal use of this species ?—What is the colour of the marble.

brown, containing shells which form circles or semicircles, of a golden colour; also shells, which in certain directions throw out blood-red reflections, similar to the Labrador feldspar. Some specimens also reflect the green and blue tints of the opal, and nearly with equal splendour.

This marble was known to the Romans. Its locality, formerly unknown, has been re-discovered. It is found in small quantities at Bleyberg, in Carinthia.

From the examination of a specimen of this singular and most beautiful marble, in the cabinet of D. Watkinson, Esq. of this city, it is obvious that the red reflections spring from the fragments of a shell: but which is not discoverable, except on close inspection.

*Panno di morto*, or funeral pall. Colour deep black, sprinkled with white shells, like snails, an inch or more in length, at distant and rather regular intervals.

This kind is sold at Rome, and is very scarce and highly esteemed. Its locality is unknown.

England produces some beautiful shell marble.

*Pentworth marble*. Colour grey, with a cast of green, and thickly set with shells, some of which are filled with white spar, giving it a variegated and beautiful appearance.

*Bristol marble*. This is a fine black marble, interspersed with white shells.

Yorkshire produces a grey marble, sprinkled with entrochites.

Italy is famous for its beautiful marbles.

Florence, Lucca, and Pisa, are decorated with a brick-red marble, containing white ammonites.

*Fiorito marble*. This kind is marked with spots resembling flowers. Two columns of it, very rich in colours, are said to have been placed in Napoleon's Museum at Paris. They were of Roman workmanship, and were discovered in the ruins of Gabium, four leagues from Rome.

*Ruin marble*, or *Pictorial marble*. This marble is found in the vicinity of Florence. It presents angular figures of a yellowish brown, running into a deep brown colour, on a base of light brown, and yellow, gradually passing into a light grey.

At a certain distance, slabs of this marble so nearly represent drawings done in bistre, on a ground of yellowish brown, that it would be difficult to convince one to the contrary.

"One is amused," says Brard, "to observe in it kinds of

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What is ruin, or pictorial marble?—What is said of this marble?

ruins; there it presents a Gothic castle half destroyed; here ruined walls; in another place, old bastions; and what still adds to the delusion is, that in these natural paintings there exists a kind of aerial perspective, very sensibly perceptible. The lower part, or what forms the first plane, has a warm, and bold tone; the second follows it, and weakens as it increases in distance; the third becomes still fainter, while the upper part presents in the distance, a whitish zone, and finally, as it reaches the top, blends itself, as it were, with the clouds."

These different colours are produced by the infiltration of different coloured oxides of iron, into the fissures of this marble. It never bears a high polish.

Fine specimens of this marble of a foot or two square, sometimes sell for exorbitant prices.

Spain offers the conchitic marbles of Grenada, and Cordova, of a deep red, with white shells.

France abounds with shell marbles.

From Narbonne, comes a deep black kind, with white belemnites.

From the department of Aube, is brought a grey marble, made up of little shells, with now and then a large ammonite.

*Caen marble.* This beautiful variety comes from Caen, in Normandy. It is of a chocolate brown, with white madrepores, of all sizes and descriptions, beautifully variegated with blue and red. Of this the tables and chimney pieces of Paris are made. In most of the coffee houses may be seen tables of this marble.

*Languedoc or St. Baum marble.* This is of a fiery red colour, mingled with white and grey shells disposed in convoluted zones.

The eight columns which decorate Napoleon's triumphal arch in the Caroussel at Paris, are of this marble.

The United States as yet presents but few localities of shell marble. Professor Cleveland has noticed the following.

In Pennsylvania, Northumberland Co. is a black marble containing white specks, like the Kilkenny marble.

In New York near Hudson, is a greyish brown marble, beautifully variegated with encrinites and other organic remains.

Near Seneca Lake is found a variegated marble, which has a fine grain, receives an excellent polish, and will probably be much employed.

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Do the United States furnish any localities of shell marble?—Where are such localities?

*Variety 1. FETID CARBONATE OF LIME.*

*External Characters.* Colour, white or greyish white; does not differ in external characters from common limestone. When scraped with a knife, or struck with a hard body, it exhales an offensive odour, resembling that of rotten eggs.

*Chemical Characters.* Before the blowpipe it loses its odour, and burns to quick lime; effervesces with acids.

The offensive odour is owing to the sulphuretted hydrogen, which probably comes from a small quantity of bitumen or sulphur, included in this variety. This quality is lost on the surface, and in small fragments, by exposure to the air.

It is sometimes found in nodular masses.

It occurs with common limestone and gypsum, and is said to form mountains.

*Localities.* Germany, France, England, &c.

U. S. Allegany Ridge, Md. Near Rhinebeck, Hyde Park, near Black river, Niagara Falls and Batavia, N. Y. Northford, Conn. Stockbridge, Mass.

*Variety 2. BITUMINOUS LIMESTONE.*

*External Characters.* Colour, brown, passing into dark brown or black; structure compact, or sometimes lamellar; when rubbed, struck or heated, emits an unpleasant bituminous odour.

*Chemical characters.* Loses both colour and odour by heat, and burns into quicklime.

It belongs to secondary rocks, and is sometimes found with coal.

*Uses.* Phillips says, that in Dalmatia, it is so bituminous that it cuts like soap, and is employed in the construction of houses; when raised, they set fire to the walls, the bitumen burns out, and the stone becomes white; the roof is then put on and the house finished. It is also polished as a marble.

*Localities.* Ireland, Scotland, England, and France.

U. S. Near Middletown, Conn. where it presents distinct impressions of fish.

*Variety 3. ARGILLO-FERRUGINOUS LIMESTONE.*

*External Characters.*—Colours, bluish, black, or greyish blue; occurs massive, in beds, and in globular and spheroidal pieces; gives an argillaceous odour when breathed on; when burnt it is of a buff colour; tougher than common limestone.

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What produces the odour in fetid carbonate of lime? What use is it to be made of bituminous limestone?

*Chemical characters.* Turns yellowish under the blow pipe ; does not fall to powder when slacked ; effervesces with acids.

*Lias* limestone, which encloses ammonites and a great variety of sea shells, with the bones of unknown animals, is similar to calp in composition. *Lias* is employed as a lithographic stone, and occurs at Lime, in Dorsetshire.

*Uses.* Calp is sometimes used as a building stone.

Some varieties form a cement which hardens under water.

*Subspecies 4.* CONCRETED CARBONATE OF LIME.

This subspecies contains two varieties, both of which appear to be formed by a succession of layers.

*Variety 1.* OOLITE. ROESTONE.\*

*External characters.* Colours, whitish, yellowish white, or ash grey ; occurs in masses composed of globular particles of the size of mustard seed, adhering by a calcareous cement ; the particles are composed of concentric layers ; fracture splintery ; opaque.

It is soft when taken from the quarry, but hardens in the air.

The houses of Bath are for the most part built of this variety of common limestone, which occurs in great beds above the mountain lime of England.—*Phillips*.

This stone is however said to be liable to disintegration, and therefore is not the best material for building.

*Variety 2.* PEASTONE. PISOLITE.

*External characters.* Colours, yellowish white, brownish, or reddish ; occurs massive, composed of distinct spheroidal concretions, which are formed of thin concentric layers, generally with a grain of sand at the centre as a nucleus ; these concretions are about the size of a pea, and are united by a calcareous cement ; they are often flattened by mutual contact.

Pisolite is found among alluvial deposits, particularly at Carlsbad in Bohemia, and in the waters that supply the baths of St. Phillip, in Tuscany. It has a singular and interesting appearance.

*Subspecies 5.* CHALK.

*External characters.* Colour, white, or yellowish white ; occurs massive ; fracture earthy ; meagre to the touch ; dull ;

\* Because it resembles the roe of a fish.

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In what form does oolite occur ?—Why is this variety called roestone ?—What is the form of peastone ?—Why is it called peastone ?

opaque; soft; soils the fingers; adheres to the tongue; gives a white streak.

*Chemical characters.* Effervesces with acids; burns to quicklime.

*Composition.* It is nearly a pure carbonate of lime.

It is one of the newest secondary formations. It often contains shells, and the remains of amphibious and land animals; also nodules of flint from which gun flints are made.

Chalk sometimes forms beds, rising into hills several hundred feet high, and which are remarkable for the smooth regularity of their outlines.

*Localities.* England, particularly in the counties of Kent, Hampshire, Berkshire, and Sussex. France in various places. Poland, and Ireland.

*Uses.* When compact, it is used as a building stone. It furnishes lime for cement and for manure, and is used in polishing metals and glass. It is also used by mechanics to mark out their work; by starchmakers and chemists to dry precipitates on, and in medicine, it is employed as an absorbent.

*Species 2. ARRAGONITE.\**

*External characters.* Colour white, or yellowish white, greenish grey, and pearl grey; occurs crystallized, in the form of six-sided prisms, with equal sides; also in six-sided prisms, of which the two opposite lateral planes are broad, the four others being narrow. These crystals on close inspection appear to have longitudinal joints down each lateral face, as though made up of several smaller crystals closely fitting each other. Sometimes the prisms are so short as to resemble octohedrons, or even tables, and sometimes it forms a peculiar kind of twin crystal, or two crystals are seen crossing each other, or a small one projecting out of the side or summit of the larger. They are often deeply striated; structure coarsely fibrous; lustre shining vitreous; translucent, or transparent; scratches marble.

Fig. 73.

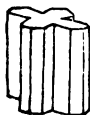


Fig. 73, a crystal, formed of four smaller crystals aggregated, so as to leave the half of each distinct.

\* Because first found at Arragon, in Spain.

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What is the colour of arragonite?—Why is it called by this name?  
What are the forms of its crystals?

**Chemical characters.** Thin fragments of transparent crystals decrepitate in the flame of a candle; other varieties lose their transparency and become friable. It phosphoresces on red hot iron, and is soluble in nitric and muriatic acid, during which process the carbonic acid is disengaged.—*Mohs*.

**Composition.** Carbonate of lime 95.2965 carbonate of strontian 0.5090; water 0.1544.—*Stromeyer*.

**Distinctive characters.** The crystalline forms, and the general aspect of arragonite will distinguish it from carbonate of lime, and from strontian. It is also harder than carbonate of lime, and does not, like strontian, tinge flame purple, but burns to quicklime.

The phosphorescence takes place, only when the particles are small, and at the instant they fall on the hot iron.

In a fine specimen of arragonite before me, from Weir's cave, Va. the largest crystals appear to consist of bundles of smaller ones adhering together, and terminating in one, two, or three-sided summits. Among the smaller ones, some are gradually and finely acuminate, while others are abruptly truncated, and terminate in one, or two principal faces. Some appear to be cylindrical, and stand in aggregated radiating masses, the points only appearing distinct; others are branched, sending forth smaller crystals under various and uncertain angles; the whole being garnished at every point with fine crystals, standing in every direction.

The branched variety is often found in the cavities of iron ore, and hence has been called *flos ferri*, or *flowers of iron*.

It was first found at Arragon in Spain, associated with gypsum.

**Localities.** Hungary, Transylvania, Bohemia, Scotland, Iceland, Siberia, Chimborazo, &c.

U. S. Weir's cave, Va. Suckasunny mine, N. J.

### *Species 3.* MAGNESIAN CARBONATE OF LIME.

This species has several varieties, which vary considerably in the proportion of lime and magnesia.

#### *Variety 1.* DOLOMITE.\*

**External characters.** Colour, white, often with a tinge of yellow, or grey; occurs massive, often of a slaty texture; consists of fine crystalline grains, which are lamellar; lustre

\* From the celebrated Dolomieu.

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How does this species differ from carbonate of lime?—Where is it found in this country?

glimmering ; translucent on the edges ; when struck, or thrown on a hot iron, mostly emits a phosphorescent light, which is visible in the dark ; softer than primitive limestone, which it strongly resembles : sp. gr. 2.85.

*Chemical characters.* Effervesces feebly with acids ; under the blow pipe, after the carbonic acid is expelled, it phosphoresces with exceeding brightness, turns opaque and falls into grains.

*Composition.* Carbonate of lime 52.0 ; carbonate of magnesia 46.5 ; oxide of iron and manganese 0.75.—*Klaproth.*

*Distinctive characters.* Its slow effervescence will distinguish it from primitive limestone.

It is found in veins, in primitive rocks, with iron, primitive limestone, tremolite, lead, zinc, quartz, &c.

*Localities.* Pyrennees, Saxony, France, Sweden, &c.

U. S. Near the city of New-York. Washington, Milford hills, and Litchfield, Conn. Great Barrington, Sheffield, Stockbridge, Pittsfield, Williamstown, and Adams, Mass.

**Variety 4. BITTER SPAR. RHOMB SPAR.**

*External characters.* Colours, greyish or yellowish white ; occurs in obtuse rhomboidal crystals, the alternate angles of which are  $106^{\circ} 15'$  and  $73^{\circ} 45'$  ; structure foliated ; lustre pearly and shining : cleaves into rhomboids ; translucent ; brittle ; very easily separable into rhombs, at the natural joints by a blow.

*Chemical characters.* Burns to quicklime ; effervesces feebly with acids.

*Composition.* Carbonate of lime 52 ; carbonate of magnesia 45 ; oxide of iron 3.—*Klaproth.*

*Distinctive characters.* It is sometimes difficult to distinguish this variety from calcareous spar. In general, its slow and feeble effervescence will distinguish them. A surer method is solution in sulphuric acid, which, if magnesia be present, will be precipitated by carbonate of potash, or soda ; the solution will also be bitter.

It is found in chlorite, steatite, or serpentine, with talc, asbestos, &c.

*Localities.* Sweden, Tyrol, Siberia, &c.

U. S. Near New-Haven, Conn. Williamstown, Middlefield, and Southampton, Mass.

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Is dolomite phosphorescent ?—What property will distinguish it from primitive limestone ?—What are the colours of rhomb spar ?—With what other minerals is rhomb spar found ?



**Variety 5. MAGNESIAN LIMESTONE.**

**External characters.** Colour, yellow or buff; occurs in amorphous masses; lustre glimmering; texture somewhat sandy; translucent on the edges.

**Composition.** Carbonate of lime 61.5; carbonate of magnesia 44.8; insoluble matter 1.6.—*Thomson*.

The great range of hills, extending from Nottingham to Sunderland in England, are entirely composed of it.

The lime obtained from it is greatly esteemed for cements, being less subject to decay, owing to its absorbing less carbonic acid from the atmosphere than the lime of common limestone.—*Phillips*.

When magnesia exists in considerable quantity in a soil, it wholly destroys vegetation. Large tracts in France are barren from this circumstance.

A *flexible* variety of magnesian limestone, is found in Sunderland in England. It is slaty, and fusible. This quality is lost by drying.—*Phillips*.

**Variety 6. FERRO-MAGNESIAN CARBONATE OF LIME. PEARL-SPAR.**

**External characters.** Colours, white or greyish, yellowish, or reddish white; occurs in laminated masses, and in obtuse rhomboids, with curved faces; sometimes only the thin edges or angles of the crystal are curved, or turned up; lustre pearly; structure foliated; crystals often placed partly over each other, so as to give the mass a scaly appearance; also, it occurs of a fibrous texture; translucent; sp. gr. 2.5.

Fig. 74.

Fig. 75.



Figs. 74 and 75, show the common appearance of these crystals. They are irregular rhomboids, having their faces curved, or their angles contorted in various directions.

**Chemical characters.** Before the blow pipe, it decrepitates with violence, and turns dark grey, or brown; with borax it fuses with ebullition, into a yellowish green enamel; soluble slowly, and with little effervescence in nitric acid.

**Composition.** Lime 27.97; magnesia 21.14; carbonic acid 44.6; oxide of iron 3.4; of manganese 1.5.—*Heisinger*.

**Distinctive characters.** Its peculiar contorted crystalliza-

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What effect does magnesian limestone have on vegetation?—Of what is pearl-spar a variety?—What is there peculiar in its crystals?—What are its chemical characters?—What are its distinctive characters?

tion, with its slow effervescence, will distinguish it from rhomb-spar, and other carbonates; sparry iron ore is darker and heavier.

Phillips thinks it probable that pearl-spar passes into sparry iron ore.

Pearl-spar is found in metallic mines, with quartz, limestone, iron ore, zinc, lead, &c.

*Localities.* Derbyshire, Devonshire, Cornwall.

U. S. Near Lancaster, Penn. Leicester, on the Genesee, Clinton, and Bethlehem, N. Y. Leverett, and Charlestown, Mass.

#### *Species 4. TABULAR SPAR.*

*External characters.* Colours, greyish white, often tinged red, green, or yellow; occurs massive, composed of thin laminae; structure imperfectly foliated; translucent, or opaque; phosphorescent when scratched; cleaves into prismatic pieces; fracture splintery; yields to the knife, and is sometimes friable: sp. gr. 2.8.

*Chemical characters.* In nitric acid, a few bubbles escape and the fragment falls into powder. Fusible with ebullition into a white glass.

*Composition.* Silice 50; lime 45; water 5.—*Klaproth.*

It is a rare mineral, and has been found only in Ceylon, and two or three other localities.

#### *Species 5. PHOSPHATE OF LIME.*

This species embraces several varieties, which vary considerably in their external characters, and chemical composition.

##### *Variety 1. APATITE\*.*

*External characters.* Colours, white, yellowish white, greenish yellow, blue, bluish green, and reddish, colours pale; occurs in six-sided prisms, terminated by one or more planes, or by a six-sided pyramid, variously truncated; prisms short; cross fracture conchoidal; lustre vitreous; translucent; often longitudinally striated; yields to the knife.

\* From the Greek, signifying to deceive, because it resembles other minerals.

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What are the colours of tabular spar?—Is this a common or a rare mineral?—What are the colours of apatite?—Why is it called by this name?

Fig. 76.

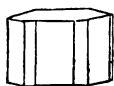


Fig. 77.

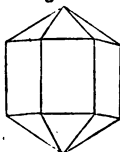


Fig. 78.

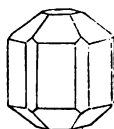


Fig. 76, the primary form, a short six-sided prism.

Fig. 77, a six-sided prism, terminated by six-sided pyramids.

Fig. 78, the same, with the lateral edges and summits truncated.

*Chemical characters.* Infusible; dissolves slowly and without effervescence, in nitric acid; or effervesces slightly from foreign matter; phosphoresces on hot iron.

*Composition.* Lime 55; phosphoric acid 45.—*Klaproth.*

*Distinctive characters.* It resembles beryl, and emerald, but wants their hardness, and is soluble in acids. From carbonate of lime it differs, by its slight effervescence; fluoate of lime is fusible.

It is found in primitive rocks, with garnets, fluor, tin, iron, and quartz.

*Localities.* Bohemia, Saxony, Moravia, Spain, several parts of England, &c.

U. S. Germantown, and Hamilton, Penn. At the former place it is in grass-green crystals. Several places in New-Jersey. Near Wilmington, Del. Near Crown Point, colour clove brown. Near New-York, colour apple green; and West Farms, N. Y. Milford hills, (pale green,) Conn. Topsham, (pale green,) Maine.

#### Variety 2. ASPARAGUS STONE.

*External characters.* Colours, asparagus green, greenish white, white and transparent; occurs in crystals only; form, six-sided prisms, with six-sided pyramidal terminations; planes sometimes striated longitudinally; angles subject to truncation; does not phosphoresce.

*Chemical characters.* Dissolves in nitrous acid without effervescence.

*Composition.* Lime 54.28; phosphoric acid 45.72.—*Klaproth.*

*Distinctive characters.* It has been confounded with apatite, but differs from it in colour; in the general smooth sur-

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What are its crystalline forms?—How is it distinguished from emerald and beryl?—How does asparagus stone differ from apatite?

face of its planes; in its acuter terminations; in its non-phosphorescence; and in dissolving in acids without effervescence.—*Jameson*.

It is found in primitive rocks.

*Localities.* Grenada, in Spain, in abundance; Vesuvius, Norway, and near Havre, in France.

U. S. Germantown, Penn. Highlands, at Anthony's Nose. Near Lake Champlain, and on the island of New-York, N. Y. Morris county, N. J.

*Species 6.* FLUATE OF LIME. FLUOR.\*

This species is found crystallized, nodular, compact, and earthy. It therefore comprehends several varieties, of which the crystallized is by far the most beautiful, and important.

*Variety 1.* CRYSTALLIZED FLUATE OF LIME.

*External characters.* Colours, purple, red, green, yellow, grey, blue, white, and perfectly limpid and transparent; occurs in crystals; forms, the octohedron, with its varieties, the cube and rhomboidal dodecahedrons, variously truncated; structure lamellar, or foliated; cleaves into the form of the octohedron, tetrahedron, and rhomboid; lustre, shining vitreous; crystals generally smooth; yields easily to the knife: sp. gr. 3.10.

Fig. 79.

Fig. 80.

Fig. 81.

Fig. 82.

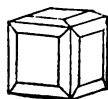
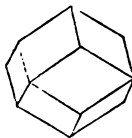
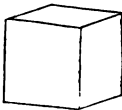
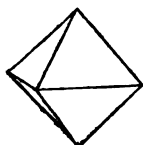


Fig. 79, the primary octohedron.

Fig. 80, the cube, a form under which it most frequently occurs.

Fig. 81, the dodecahedron, with rhombic faces.

Fig. 82, the cube, with bevelled edges.

Fig. 83

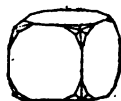


Fig. 83. the cube, with each solid angle bevelled, or replaced with six planes.

\* From the Latin *fluo* to flow, because it is used as a flux.

What are these minerals composed of?—What are the colours of fluates of lime?—What are the forms of its crystals?

A great variety of other forms are enumerated. Mr. Phillips states that his collection presents upwards of seventy varieties of form. The same author has given a figure of one crystal, bounded by fifty-four planes, and another in his possession from Devonshire, bounded by three hundred and twenty-two planes.

This mineral is rendered very interesting by the great variety and beauty of its colours, and the peculiarly distinct forms in which its crystals are often found.

*Chemical characters.* Fusible with ebullition into an opaque globule; with borax into a transparent glass. In powder, with warm sulphuric acid, emits fluoric acid gas, which is employed in etching on glass; phosphorescent on hot iron.

*Composition.* Lime 72.14; fluoric acid 27.86.—*Berzelius.*

*Distinctive characters.* Its rich colours and peculiar property of corroding glass will distinguish it from other minerals; from the gems it is readily known, by its want of hardness.

It is found mostly in metallic veins which traverse primitive rocks.

*Localities.* Mount Blanc, St. Gothard, Saxony, Germany. Cornwall and Derbyshire, abundant. In the tin mine, St. Agnes, Cornwall, are found the most splendid varieties; also in the lead mines of Derbyshire, fine specimens occur.

U. S. Shenandoah county, and at Shepherdstown, Va. Peter's Creek, 17 miles from Shawneetown, Fork of Grand Pierre Creek, 27 miles from the same place, Illinois. West side of the Blue Ridge, Md. Smith county, Ten. Near Franklin Furnace, and near Hamburgh, N. J. Near Saratoga Springs, N. Y. At Middletown and Huntington, Conn. At Thetford, Vt. Southampton lead mine, Mass. White Mountains, N. H.

#### *Variety 1.* NODULAR FLUATE OF LIME.

*External characters.* Colours, blue, brown, purple, grey, reddish, and yellow, variously intermixed with white, and transparent; it is the result of imperfect crystallizations; the colours run in zones or bands, often quite distinct, or are variously shaded, or intermingled with each other, forming tints of a great variety of colours. Some parts of a specimen will be transparent, others translucent, or even opaque.

This variety comes from Derbyshire, and is commonly

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What is the composition of fluor spar?—What acid is obtained from fluor, and what are its peculiar properties?

known by the name of Derbyshire-spar. It is called *blue john* by the miners, and is found in veins or detached masses, from three inches to a foot in thickness.

*Uses.* It is formed into vases, obelisks, candlesticks, &c. for ornamental purposes. It bears a high polish, and its great variety of rich colours renders it remarkably beautiful, and in great request.

*Variety 2. CHLOROPHANE.\**

*External characters.* Colour, pale violet; structure imperfectly lamellar; does not much resemble the other varieties; translucent.

It is curious on account of its phosphorescence. When placed on hot iron, it does not fly, but gives out the most beautiful emerald green light. The experiment may be made on a hot shovel carried into the dark.

*Localities.* Cornwall and Siberia.

*U. S.* New Stratford, Ct. When placed on a hot iron in a dark room, it emits a very pure emerald green light; masses even one inch in diameter, become illuminated in a few seconds, and continue distinctly luminous when removed to a room lighted by candles, or when viewed in weak day light—*Silliman.*

*Species 7. SULPHATE OF LIME.*

The varieties of this species differ widely in their external characters, but are composed of nearly the same proportions of lime and sulphuric acid.

It occurs crystallized, fibrous, granular, earthy, and compact.

*Variety 1. CRYSTALLIZED SULPHATE OF LIME. SELENITE.*

*External characters.* Colours, white, either pure, or with shades of yellow, violet, brown or red; occurs in foliated masses, and in regular crystals; form of the foliated, oblique hexahedral tables, each of the lateral faces of which is bevelled; or in flat crystals which are oblique parallelopipeds; form of the regular crystals, hexahedral and octohedral prisms, with oblique terminations; crystals often united, somewhat in the stellular form, or the smaller crystals are attached obliquely to the larger ones; structure foliated; cleavage very per-

\* From its green light, when heated.

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What is the common name of fluor?—What are the uses of this mineral?—Whence does chlorophane derive its name?—What curious property does it possess?

fect in one direction; lustre, shining pearly; transparent or translucent; soft; yields to the nail; inelastic: sp. gr. 2.310.

*Chemical characters.* Turns white and opaque, swells, and finally, in small fragments, melts into a white enamel; does not effervesce with acids, nor burn to lime.

*Composition.* Lime 32; sulphuric acid 46; water 22.—*Bergman.*

*Distinctive characters.* It resembles mica and talc; but mica is elastic, does not instantly turn opaque on being heated, and is harder than selenite; talc is unctuous to the touch, and of a greenish tinge.

The massive selinite sometimes appears in broad, shining, transparent laminae, a foot or more long, and several inches wide, without the least appearance of distinct crystals, but resembling plates of mica.

Beautiful specimens of this kind are occasionally found among the gypsum from Nova Scotia.

Selenite often occurs in the form of *lenticular* crystals. These sometimes occur disseminated in the compact, or granular gypsum, or are collected into groups in the form of roses, stars, &c.

#### *Variety 2. FIBROUS GYPSUM.*

*External characters.* Colours, white, grey, reddish, and yellowish; occurs in extremely fine, delicate, and nearly separate fibres, of a shining silky lustre, and either straight, or gently curved; sometimes it is nearly compact, taking the form of a concretion.

This beautiful variety is polished for ornamental purposes.

#### *Variety 3. GRANULAR GYPSUM.*

*External characters.* Colours, white, yellowish, and reddish; occurs in masses composed of small laminated crystals, which present shining faces, either straight or curved; translucent on the edges; very soft; yields to the nail.

This is a very common variety, and appears to be intermediate between selenite and compact gypsum.

#### *Variety 4. COMPACT GYPSUM.*

*External characters.* Colours, white, reddish, or yellowish, often running in veins, or clouds; occurs massive; fracture compact; lustre glimmering; translucent, or opaque; easily cut with a knife; the white, often resembles spermaceti.

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What is the composition of sulphate of lime?—In what forms does it occur?—What are its chemical and distinctive characters?—What are the prevailing colours of this mineral?

This variety forms the gypseous alabaster of which cups, vases, candlesticks, and other ornaments are made; some specimens after being polished, are translucent, and at a few feet distance can hardly be distinguished from spermaceti. Beautiful ornaments of this mineral, and in great variety, come from Italy. A manufactory of the same kind is also established at Derby, England.

The beautiful white translucent alabaster, of which the Italian ornaments now so common in this country, are made, comes from Castelino, in Tuscany, 35 miles from Leghorn. The most perfect is found about 200 feet below the surface of the earth. The yellowish variegated kind called *alabastro agatato*, or agate alabaster, is found at Sienna, from 20 to 30 feet below the surface.

The bluish variety comes from Guercieto, and is remarkably beautiful, being elegantly variegated with blue, purple, and red.

The principal manufactory of these articles is at Volterra, 36 miles from Leghorn, where about 5,000 persons live by this kind of labour, and from whence these ornaments are transported to all parts of the world.

This information we obtain from one of the proprietors of the manufactory.

This kind of alabaster may be readily known from the calcareous kind, by its softness and want of effervescence with acids.

#### Variety 5. PLASTER OF PARIS.

*External characters.* Colour, yellowish, or brownish; occurs in masses, composed of small grains, sometimes of a crystalline appearance, and sometimes earthy; fracture earthy; dull; soft; easily broken; yields to the nail.

*Chemical characters.* Effervesces slightly with acids, owing to its containing a portion of lime. In other respects its chemical characters do not differ from the other varieties.

*Composition.* That of Montmatre, near Paris, contains about 17 per cent. of carbonate of lime, and a small portion of the oxide of iron.

Plaster of Paris is the name commonly used in commerce for the whole species, probably from the circumstance of its having been first exported from the vicinity of Paris.

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What use is made of the compact variety?—Under what name is this variety known?—How may this alabaster be known from the calcareous kind?—What is the appearance of plaster of Paris?—Why is this mineral called plaster of Paris?



This variety occurs in great abundance at Montmatre, near Paris, and is said to produce the best plaster known in commerce.

Sulphate of lime belongs to transition and secondary formations. Its occurrence as a primitive rock has also been asserted. But Saussure, who observed gypsum in several places on the Alps, mixed with layers of mica, has notwithstanding recorded his opinion against its primitive origin. The gypsum of Nova Scotia, of which vast quantities are employed for manure and other purposes, presents, it is believed, no organic remains. Having examined great quantities of this gypsum, with a view to determine its geological character, and having interested the workmen, where it is broken and ground, to observe any organic remains that might occur, the writer has never been able to detect a single shell, or other organized substance in it.

The secondary gypsum of Germany, it is believed, sometimes contains organic remains.

That of Montmatre contains vast quantities of shells, skeletons of birds, quadrupeds, and even vegetable substances.—*Cuvier. Pinkerton.*

*Uses.* Gypsum is ground and spread on certain soils as a manure. (For information on this subject, see *Davy's Agricultural Chemistry*.)

It is employed when calcined, in ornamenting rooms in *stucco*, in taking the impressions of medals, in casting statues and busts, &c. and when mixed with lime, it is used in plastering the walls of houses.

Casts, busts, &c. of plaster, are easily polished when dry, by rubbing the surface with talc.

*Remark.* Broken articles of plaster are mended by first wetting the surfaces to be joined, then mixing the calcined plaister with gum water, and applying it before it hardens.

*Localities.* Hungary, Italy, Bohemia, England, and most other countries. Nova Scotia, in extensive quarries.

*U. S.* Niagara, near the Falls, and at the foot of Goat Island. Onondaga and Madison Counties, near Cayuga Lake, (at the three last named places it is quarried.) Manlius, Lockport, and in several other places, N. Y. Martha's Vineyard, and Milton, Mass. Saltville, on Holstein river, (quarried,)

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Why does it sometimes effervesce with acids?—What are the principal uses of plaster of Paris?—Is this mineral common in this country?

near Preston's salt works, and at the head waters of Staunton river, Va. St. Mary's county, on the Patuxet, on the Potomac, near Fort Washington, and near Baltimore, Md. It is also found in many other places in the U. States, in small quantities.

*Species 8. ANHYDROUS\* GYPSUM.*

This species occurs crystallized, granular, fibrous, and compact. It therefore affords several varieties.

*Variety 1. MURIACITE.†*

*External characters.* Colours, white, violet, bluish, or reddish; occurs crystallized in rectangular prisms, sometimes differing little from a cube, and sometimes so short as to become tabular; structure lamellar, with joints parallel to the planes of the prism; lustre shining pearly; transparent or translucent; soft; yields to the nail.

*Chemical characters.* Infusible, but is reduced without exfoliation to a white friable enamel; does not effervesce with acids.

*Composition.* Lime 40; sulphuric acid 60.—*Vauquelin.*

Lime 41.75; sulphuric acid 55; muriate of soda 1.—*Klaproth.*

*Distinctive characters.* It does not, like the sulphate of lime, exfoliate and melt into a hard enamel, but under the blow pipe is converted into a friable enamel.

*Localities.* Switzerland, and Tyrol.

U. S. Lockport, N. Y.

*Variety 2. GRANULAR ANHYDRITE.*

*External characters.* Colours, greyish, greenish grey, bluish or reddish; occurs in concretions; structure granular, or confusedly foliated, sometimes bladed, or contorted; lustre shining, pearly; translucent.

It often contains a little muriate of soda.

*Variety 3. FIBROUS ANHYDRITE.*

*External characters.* Colours, greyish, greenish grey, bluish or reddish; occurs in masses composed of fibres, either straight and parallel, or diverging; translucent on the edges; lustre, shining, pearly.

\* Anhydrous, without water, because it contains no water of crystallization.

† Muriacite, because it sometimes contains muriatic acid.

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Whence come the words anhydrous and muriacite?—What are the prevailing colours of muriacite?—What is the composition of this species?—What are its varieties?

**Variety 4. COMPACT ANHYDRITE.**

*External characters.* Colours, white, grey, blue and red ; occurs massive and sometimes contorted ; fracture splintery passing into flat conchoidal ; translucent on the edges ; scratches calcareous spar.

*Composition.* Lime 42 ; sulphuric acid 56.50 ; muriate of soda 0.25.—*Klaproth.*

*Localities.* It is found in the salt mines of Poland.

**Variety 5. SILICEOUS ANHYDRITE.**

*External characters.* Colours, greyish white, veined with bluish grey ; occurs in distinct massive concretions ; structure laminated ; translucent on the edges ; lustre, splendid ; soft ; brittle.

*Composition.* It contains 8 per cent. of silex.—*Vauquelin.*

It is found with limestone at Vulpino, in Italy.

It takes a fine polish and is employed for ornamental purposes.

**Species 9. NITRATE OF LIME.**

*External characters.* Colours, white, yellowish, or greyish white ; occurs in fibrous efflorescences ; often united in the form of silken tufts, also in delicate needles, and in a state of powder ; tastes bitter and disagreeable.

*Chemical characters.* On burning coals it slowly melts away, and emits slight detonations ; soluble in water and very deliquescent.

*Composition.* Lime 32 ; nitric acid 57.44 ; water 10.57.—*Klaproth.*

*Distinctive characters.* Its bitter taste, and its ready deliquescence will distinguish it from nitrate of potash.

It is generally found with the nitrate of potash, and occurs about old walls, in caverns, and on calcareous rocks among vegetable remains.

*Localities.* U. S. It is abundant in the caverns of Kentucky.

**Species 10. SILICEOUS BORATE OF LIME.**

*External characters.* Colour, greyish or greenish white ; occurs massive and crystallized ; form, the rhombic prism, with the lateral edges, and solid angles, variously truncated ; sometimes the two opposite angles, and sometimes all the angles are truncated, or bevelled ; the two opposite angles are

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Of what is nitrate of lime composed ?—What are its chemical and distinctive characters ?

often replaced by three planes, forming a prism of ten sides; fracture imperfectly conchoidal; lustre shining between vitreous and resinous; translucent; yields to the knife; sp. gr. about 3.

*Chemical characters.* Intumesces into a white mass, and then melts into a globule of a pale rose colour; forms a jelly with acids; in the flame of a candle, turns white, opaque, and becomes friable.

*Composition.* Lime 84; boracic acid 21.67; silice 37.66; water 55.—*Vauquelin.*

*Distinctive characters.* It sometimes resembles prehnite; but is not electric by heat, and its hardness is sensibly inferior.—*Cleveland.*

*Variety.* BOTRYOLITE.\*

*External characters.* Colour, white, greyish, and red in concentric circles; externally yellowish grey; occurs in botryoidal masses, and in mamillary concretions, formed of concentric layers; texture fibrous or earthy; sp. gr. 2.8.

*Composition.* Lime 39.5; silice 36; boracic acid 13.5; water 6.5; oxide of iron 1.—*Klaproth.*

This species is found at Arendal, in Norway.

U. S. Near Passaic Falls, N. J. It was discovered by J. Pierce, Esq. and is well characterized.

*Species 11.* ARSENIATE OF LIME.

*External characters.* Colour, white, or greyish white; surface often tinged red, or violet by arseniate of cobalt; occurs in minute fibres, or in acicular crystals, commonly aggregated into botryoidal masses; lustre silky, or dull; sp. gr. 2.6.

*Chemical characters.* Evaporates with heat in dense white vapour, with the odour of arsenic, leaving the lime. Soluble in nitric acid without effervescence.

*Composition.* Lime 25; arsenic acid 50.54; water 24.46.—*Klaproth.*

*Distinctive characters.* Its chemical characters will distinguish it from the minerals it most resembles.

*Localities.* Andreasburg in the Hartz. Near Furstemburg, in Germany, with Cobalt and sulphate of lime.

\* From the Greek, resembling grapes.

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What is the composition of silicious borate of lime?—Why is one of its varieties called botryolite?—What is the composition of arseniate of lime?—Is it a common mineral?

*Genus 2. ALUMINE.*

This earth derives its name from alum, of which it is the base. It never occurs pure, but may be obtained so by chemical means, when it is of a clear white. It occurs very universally in argillaceous soils, and enters into the composition of several gems, as the sapphire and ruby. In the species belonging to this genus, it is combined with acids, and forms the basis of several salts.

*Species 1. SUBSULPHATE OF ALUMINE.*

*External characters.* Colour, white, or yellowish white; occurs massive in small round or reniform pieces; translucent, or opaque; fracture earthy; yields to the nail; adheres to the tongue; light.

*Chemical characters.* Infusible, but loses more than half its weight by the heat.

*Composition.* Alumine 30.2; sulphuric acid 23.4; water 46.4.—*Stromeyer.*

*Localities.* Newhaven, Sussex, Eng. Halle, in Saxony.

*Variety 1. SILICIOUS SUBSULPHATE OF ALUMINE.*

*External characters.* Colour, between milk and show white; occurs of the consistence of hog's lard; smooth to the touch; translucent, except in patches, where it is opaque and granular; on exposure to the air, it dries and splits into masses like starch, some of which effervesce on the surface, while others are translucent, and resemble the finest pieces of gum arabic.—*Phillips.*

*Chemical characters.* By ignition it loses 90 per cent. of its weight.

*Composition.* Alumine 6.5; sulphuric acid 3.0; water 88; silice 2.4.—*Henry.*

*Localities.* This singular mineral was found in the old workings of a coal mine, near Oldham, in Lancashire.

*Species 2. SUBPHOSPHATE OF ALUMINE.*

*External characters.* Colours white, yellowish white, greenish or bluish; occurs in minute crystals in the form of rhombic prisms, with dihedral terminations; these are grouped, or collected into hemispherical, or globular concretions; sometimes appearing like down, but more commonly radiating from a centre, with a pearly or silken lustre. It is often attached to

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Whence does the earth alumine derive its name?—What is the composition of subsulphate of alumine?

other minerals, in distinct, round, or stellular spots, presenting, when the mineral is of a different colour, a singular and beautiful appearance; translucent.

*Chemical characters.* Infusible, but becomes white and opaque, and loses its crystalline form; gives a greenish tinge to the flame; Aiken says, that with sulphuric acid it corrodes glass.

*Composition.* Alumine 35.35; phosphoric acid 33.40; fluoric acid 2.06; lime 0.50; water 26.90; oxides of iron and manganese 1.25.—*Berzelius.*

*Distinctive characters.* It resembles zeolite, but this is fusible. Its property of corroding glass is not constant, but may sometimes be seen by placing a little of it in powder with sulphuric acid on a piece of glass and warming it over a lamp.

*Localities.* Barnstable, in Devonshire; Cornwall; New-  
Castle, and other places in England. Brazil, Bohemia, and the Hebrides. First discovered at Barnstable, by Dr. Wavel.

A mineral found at Richmond, in Berkshire county, Mass. is supposed to belong to the present species. It occurs stalactical, or in concretions composed of minute radiating fibres; colour greenish or greyish white; scratches carbonate of lime. Infusible.

### Genus 3. MAGNESIA.

Like the other earths, magnesia when pure, is perfectly white. That sold by apothecaries, is obtained by the decomposition of the sulphate of magnesia. It is also found native, in small quantities. It enters into the composition of a considerable variety of minerals. It forms the basis of several native salts, being found combined with the carbonic, sulphuric, and boracic acids.

#### Species 1. CARBONATE OF MAGNESIA.

Of this species there are four varieties, viz. crystallized, compact, earthy, and pulverulent.

##### Variety 1. CRYSTALLIZED CARBONATE OF MAGNESIA.

*External characters.* Colour, white; occurs in delicate acicular crystals, radiating, or diverging, and possessing the lustre of satin; also in flesh coloured crusts, not more than two lines thick, having a polished, or sparry structure. It is totally soluble in sulphuric acid.—*Cleveland.*

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What are the colours, chemical and distinctive characters of subphosphate of alumine?—How is the earth magnesia obtained?—With what acids is this earth found combined?

*Localities.* Staten Island, N. Y. Discovered by James Pierce, Esq. in veins, or cavities, in magnesite and steatite.

**Variety 2. COMPACT CARBONATE OF MAGNESIA.**

*External characters.* Colours, grey, or yellowish; occurs amorphous, tuberous, and spongiform; fracture, dull, splintery, and flat conchoidal; nearly opaque; yields to the nail externally; internally harder than calcareous spar; adheres to the tongue; absorbs from 9 to 10 per cent of water, and becomes translucent on the edges.

*Chemical characters.* Soluble with effervescence, but slowly, in muriatic and sulphuric acids; infusible, but hardens under the blow pipe so as to scratch glass.—*Aikin.*

*Composition.* Magnesia 58; carbonic acid 49; water 3.—*Klaproth.*

*Distinctive characters.* The bitter solution which it forms when dissolved in sulphuric acid, and its not burning to quick lime, will distinguish it from chalk, and other forms of carbonate of lime. It does not, like clay, become plastic with water.

*Localities.* Upper Stiria, Moravia, Italy, Spain, and Silesia. U. S. Bare Hills, near Baltimore.

**Variety 3. EARTHY CARBONATE OF MAGNESIA.**

*External characters.* Colour whitish or yellowish white; occurs in porous masses; fracture earthy; yields easily to the nail; adheres to the tongue; sometimes swims on water.

*Localities.* Samos, Negropont, Moravia, and Cornwall.

It is called *Meerschaum* in the east, and is used for the same purposes as fuller's earth is with us.

**Variety 4. PULVERULENT CARBONATE OF MAGNESIA.**

*External characters.* Colour yellowish white; occurs in small masses, which fall to powder on drying; soft to the touch; soils the fingers; soluble in sulphuric acid.

*Localities.* India.

U. S. Hoboken, N. J. Discovered by James Pierce, Esq. Staten Island, N. Y. Roxborough, Penn.

**Species 2. SULPHATE OF MAGNESIA.**

*External characters.* Colour, white, or greyish white; occurs in crystalline fibres, adhering together longitudinally; lustre silky or pearly; translucent; not very brittle; taste, bitter and nauseous.

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Where has crystallized carbonate of magnesia been found?—What are the chemical and distinctive characters of this species?

*Chemical characters.* Soluble in water, from which it is precipitated by the carbonate of potash or soda. Under the blow pipe, it boils, gives off its water of crystallization, and remains a white, infusible, spongy mass. It is composed of magnesia and sulphuric acid.

It is found on the surface of decomposing gypsum, or schistus, on the surface of particular soils, and in mineral waters.

*Localities.* Epsom,\* in England, and Seidlitz, in Bohemia. At these places it is abundant in mineral springs.

U. S. Mammoth Cave, Ky. Greenbriar, and Monroe counties, Va. Near Corydon, In. in abundance. Coeymans, N. Y.

### *Species 3. BORATE OF MAGNESIA.*

*External characters.* Colours, yellowish, greyish, or greenish white; occurs crystallized in the form of a cube, variously modified by truncation; sometimes all the edges are truncated, but in every case the diagonally opposite angles are differently modified, sometimes by simple truncation, and sometimes by bevelment; the solid angles are subject to the same diversity: fracture uneven, passing into flat conchoidal; lustre glistening; transparent or translucent; sometimes gives sparks with steel; pyro-electric, the opposite angles being in opposite electrical states.

*Chemical characters.* Fusible into an opaque white glass.

*Composition.* Magnesia 16.6; boracic acid 83.4.—*Vauquelin.*

*Distinctive characters.* Its character of possessing opposite electricities at its opposite angles, and the dissimilar opposite modifications of its angles, will distinguish it from all other minerals which it resembles.

*Localities.* Lower Saxony, embedded in Gypsum; near Kiel, in Holstein, embedded in anhydrous gypsum.

### *Genus 4. BARYTES.*

When pure, barytes is white, has a caustic, somewhat alkaline taste, and by the chemists is placed among the alkaline earths. It is a strong poison. It never occurs pure in nature,

\* Whence Epsom salt, the common name of the species.

What is the composition of the sulphate of magnesia?—What is the common name of this salt, and whence does it receive this name?—In what is borate of magnesia found?—What is the composition of this salt?—What are the chemical and distinctive characters of this salt?—What are the properties of barytes?



but is found combined with the carbonic and sulphuric acids, forming carbonate of barytes, and sulphate of barytes.

*Species 1. CARBONATE OF BARYTES.*

*External characters.* Colours, white, or greyish white, or yellowish, bluish, or greenish; occurs massive, stalactical, and in crystals; form, resembling closely the common crystals of quartz, viz. six-sided prisms, terminated by six-sided pyramids; sometimes with the apices truncated; fracture of the massive undulated; structure fibrous or bladed; lustre glistening; translucent or opaque; scratches carbonate of lime: sp. gr. 4.4.

*Chemical characters.* Fusible into a white enamel; soluble with effervescence, in dilute nitric, or muriatic acid, a little of which tinges burning alcohol yellow.

*Composition.* Barytes 78; carbonic acid 22.—*Klaproth.*

*Distinctive characters.*—Its weight will distinguish it from the minerals it resembles, except strontian and the sulphate of barytes. The sulphate does not effervesce; and carbonate of strontian, when dissolved in an acid, and mixed with alcohol, tinges the flame purple, instead of yellow.

The cells of the massive variety of this substance, often contain the crystallized variety.

When reduced to thin plates, it gives by refracted light, two images, one bright, and the other nebulous.—*Cleveland.*

The native carbonate of barytes, is next to arsenic, one of the strongest of mineral poisons. When dissolved in muriatic acid, it is employed in minute doses, as a remedy in certain diseases.

*Localities.* It was first discovered by Dr. Withering in Lancashire, England, hence Witherite, one of its names. It has since been found in several other places in England, in Hungary, Stiria, and Siberia.

*U. S.* Near Lexington, Ky.

*Species 2. SULPHATE OF BARYTES.*

*External characters.* Colours, white, yellowish white, flesh red, greenish white, and bluish; occurs crystallized and massive; primitive form, a right four-sided prism, whose bases are rhombs; subject to a variety of modifications by truncation; structure lamellar, with cleavage in three directions; crystals

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What are the native salts of barytes?—What is said of the poisonous property of carbonate of barytes?—Is it rare or not?—What are the prevailing colours of sulphate of barytes?

sometimes curved ; lustre shining, between pearly and vitreous ; yields easily to the knife ; translucent : *sp. gr.* 4.446.—*Mohs.*

These crystals are generally so short, as to take the tabular form.

Fig. 84.

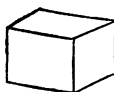


Fig. 84. The primary form, a right prism, with rhombic bases.

*Chemical characters.* Decrepitates, becomes vitrified on the outside, and finally melts into an opake white enamel. If coloured with oxide of copper, the flame, on the first application of heat, is tinged green, otherwise not ; if the enamel be applied to the tongue, it tastes like rotten eggs ; it does not effervesce with acids.

*Composition.* Barytes 67 ; sulphuric acid 33.—*Klaproth.*

*Distinctive characters.* Its specific gravity will distinguish it from the minerals it most resembles, except strontian, carbonate of barytes, and carbonate of lead. Strontian after fusion never gives the fetid taste of barytes ; it gives a purple flame, when dissolved in acid, and burned with alcohol ; carbonate of strontian effervesces ; carbonate of lead effervesces, and is reduced to the metallic state under the blow-pipe.

Sulphate of barytes is found in considerable variety of form and structure, and therefore admits of a number of subdivisions.

Among the more remarkable tints which occur in this species, *Mohs* has noticed the following, viz. smalt blue, pale sky blue, almost indigo blue, woad-brown, and hair brown, bright red and yellow.

#### *Variety 1.* LAMELLAR SULPHATE OF BARYTES.

*External characters.* Colours, white, yellowish white, grey, reddish, bluish, or greenish ; occurs crystallized, sometimes distinct, but commonly in foliated masses ; form, the right rhombic prism, subject to a great variety of truncations, or bevelments ; crystals compressed into a tabular form ; generally aggregated into masses, so as to present, when broken, longish granular particles, of various sizes ; translucent ; lustre shining ; pearly ; fragments rhomboidal ; easily broken.

Fig. 85.



Fig. 85. A four-sided table, a common form.

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What are its chemical and distinctive characters ?—What are the crystalline forms of the lamellar sulphate of barytes ?—What are the varieties of this species ?

Fig. 86.

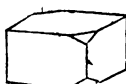


Fig. 86. A right prism with rhombic bases, modified by the truncation of its alternate solid angles.

Fig. 87.



Fig. 87. A four-sided table with truncated terminal, or narrow faces, and solid angles.



Fig. 88.



Fig. 88. The same, with the narrow faces modified by bevelment, and its angles by truncation.

The crystals are often colourless and transparent, and although generally small, Lowry mentions one, six inches long.

The laminæ of this variety are often curved, and sometimes unite in a point like the petals of a flower.

Sometimes the folia are set on their edges, forming thin crystals called cockscomb spar.

#### *Variety 2. COLUMNAR HEAVY SPAR.*

It consists of very thin crystals, which are aggregated longitudinally, or are collected into bundles, or columnar groups; structure foliated; the columns striated; lustre pearly; translucent.

#### *Variety 3. FIBROUS HEAVY-SPAR.*

*External characters.* Colour, chesnut brown; occurs in botryoidal, or reniform masses; structure fibrous; lustre, shining resinous; transparent; brittle.

*Composition.* Sulphate of barytes 99; with a trace of iron.—*Klaproth.*

#### *Variety 4. RADIATED HEAVY-SPAR.*

*External characters.* Colour, grey, or yellowish grey; occurs in roundish masses, composed of radiating minute crystals, which appear to come from the centre, and to project unequally on the surface, giving it a rough exterior; fracture foliated; translucent.

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What peculiar property has fetid sulphate of barytes?

This variety being calcined, then mixed with mucilage of gum arabic, and formed into small pieces, and again heated, has the property, after exposure to light, of shining in the dark. It is then called Bolognian phosphorus.

It is found at Bologna, in Italy, hence the name.

**Variety 5. GRANULAR HEAVY-SPAR.**

*External characters.* Colours, white, yellowish, or greyish white; occurs massive; structure finely granular; grains, crystalline and lamellar; lustre shining; feebly translucent.

*Composition.* It contains 10 per cent. of silex.—*Klaproth.*

**Variety 6. COMPACT HEAVY-SPAR.**

*External characters.* Colours, white, greyish or reddish white; occurs massive; fracture coarse, earthy, dull, soft, and brittle.

*Localities.* It is found in Bohemia, Saxony, and in the mines of Derbyshire.

**Subspecies 1. FETID SULPHATE OF BARYTES.**

*External characters.* Colours, yellowish, brownish, or blackish; occurs in globular masses; structure foliated; gives a sulphureous odour when rubbed, or heated; in other respects it resembles the common varieties.

*Composition.* Sulphate of barytes 85.2; sulphate of lime 6; alumine 1; oxide of iron 5; carbon 0.5.—*Klaproth.*

*Uses.* The pure white varieties are ground and used as a white paint, either alone or mixed with white lead, which cannot be considered as an imposition.—*Mohs.*

Crystals of the present species have been artificially obtained by dissolving sulpho-cyanuret of barium in sulphuric acid, and allowing this solution to be slowly decomposed by the influence of the atmosphere.—*Mohs.*

Sulphate of barytes is found in veins, in primitive transition and secondary rocks. Its localities are numerous, though it seldom occurs in large quantities. It is commonly found with the ores of lead, copper, zinc, &c.

*Localities.* Its foreign localities are numerous, being found in almost every country where mines are explored.

U. S. Cheshire, Berlin, Farmington, Hartford, and Southington, Con.—*Silliman.* Hatfield.—*Gorham.* Southampton.—*Eaton.* Middlefield and Greenfield, Mass.—*Hitchcock.* Livingston's lead mine.—*Shaeffer.* Little Falls, on the Mo-

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What are the uses of this species?—Is this a common or rare mineral?

hawk.—*Eaton*. The Highlands, near the Hudson, N. Y. *Pierce and Torrey*. Near Newton, Sussex County.—*Chilton*. On the west side of Paulin's Kill, and near Scotch Plains, N. J.—*Pierce and Torrey*. Perikomen lead mine.—*Wetherill*. Buck's County, 3 miles west of New Hope.—*Lea*. Bedford County, at the foot of Blue Ridge, Penn.—*Wister*. Liberty, Frederic County, and Washington County, Md.—*Hayden*. Near Lexington, Ken.—*Jessup*. Several of the lead mines, in Missouri.—*Schoolcraft*.

*Genus 5. STRONTIAN.\**

This earth in many respects resembles that of barytes. It is white and fuses with difficulty. It is never found pure in nature, but is combined with the carbonic and sulphuric acids, forming a carbonate and sulphate of strontian.

*Species 1. CARBONATE OF STRONTIAN.*

*External characters.* Colours, white, greyish, or greenish white; occurs crystallized, fibrous, massive, and stellated; form, the hexahedral prism, modified by truncation, or terminated by pyramids; structure divergently fibrous, or bladed; lustre, shining pearly; fracture, fine grained, uneven; crystals small or acicular, often attached to the massive; yields to the knife; brittle: sp. gr. nearly 4.

*Chemical characters.* Becomes glazed on the outside, but does not melt; tinges the flame purplish red; effervesces with nitric, or muriatic acid, and a paper dipped in the solution, burns with a purple flame; with borax dissolves into a clear globule.

*Composition.* Strontian 69.5; carbonic acid 30.—*Klaproth*.

*Distinctive characters.* It resembles carbonate of barytes, but the carbonate melts without tinging the flame. It is found in primitive rocks, with the ores of lead, zinc, and copper, and is often accompanied by sulphate of barytes, and calcareous spar.

It has not been discovered in the U. States.

*Species 2. SULPHATE OF STRONTIAN. CELESTINE.†*

*External characters.* Colours, white, greyish white, yellowish white, or reddish, and more rarely light blue; occurs fibrous, massive, stellated, and crystallized; form, the primi-

\* From its having been first discovered at Strontian, in Scotland.

† Sky blue, from its colour.

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Is the earth, strontian, ever found pure?—What are the chemical and distinctive characters of carbonate of strontian?

live, a right rhombic prism, the alternate angles of which, according to Phillips, are  $104^{\circ}$  and  $76^{\circ}$ ; structure lamellar, with joints parallel to the faces of the prism, that parallel to the base being particularly distinct; lustre shining, between pearly and resinous; translucent or transparent; yields to the knife; brittle: sp. gr. 3.6.

*Chemical characters.* Melts before the blow pipe into a white friable enamel, without very sensibly tinging the flame; after a short exposure to heat it becomes opaque, and then acquires a somewhat caustic, acrid flavor, very different from that of sulphuretted hydrogen, which heavy spar acquires in similar circumstances.—*Aiken*. Phosphoresces on hot iron.

*Composition.* Strontian 58; sulphuric acid 42.—*Klaproth*.

*Distinctive characters.* It resembles the carbonates of strontian and barytes, and the sulphate of barytes. But the distinctive characters given under each of those species, will distinguish this from them.

#### *Variety 1. FIBROUS CELESTINE.*

*External characters.* Colours, milk white, passing into blue, or sky blue; occurs massive, in plates and in fibrous crystals; lustre of the longitudinal fracture, shining; cross fracture glistening and pearly; fracture in one direction foliated; translucent; loses its colour in keeping; easily broken: sp. gr. 3.8.

This variety is rare. It sometimes occurs in thin beds or layers like gypsum, its fibres being perpendicular to the sides of the bed.—*Cleveland*.

*Localities.* Montmatre, near Paris, Switzerland, Sicily, and in several places in England and Scotland.

U. S. Frankstown, in the Bald Eagle mountain, Penn.

#### *Variety 2. FOLIATED CELESTINE.*

*External characters.* Colours, white, grey, bluish, or sky blue; occurs massive, and crystallized, in four or six-sided prisms, variously modified; sometimes the four-sided prism is terminated by four-sided pyramids; and sometimes the termination is dihedral; often this form is deeply truncated on its lateral edges, so as to produce a six-sided prism, crystals often flat or tabular; fracture imperfectly foliated; strongly translucent; crystals sometimes transparent.

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What is the composition of sulphate of strontian?—Why is this mineral called celestine?—What are the natural salts of strontian?

Fig. 89.



Fig. 89. A four-sided prism terminated by a two-sided summit, standing on the obtuse lateral angles of the prism.

Fig. 90.



Fig. 90. A four-sided tabular prism terminated by pentagonal, or five-sided faces.

*Localities.* Bristol and Yorkshire, England. Tyrol, and near Cadiz.

U. S. Lockport, (*Silliman*), and Moss Island, N. Y. the latter discovered by Prof. Douglass. Near Baltimore. Magnificent crystals have been found on Strontian Island, in Lake Erie.—*Mohs*.

## CLASS II.

### EARTHY MINERALS.

This Class includes such minerals as are composed of one or more earths. Some of them also contain small portions of one or more metallic oxides, which however are not considered as essential ingredients.

#### QUARTZ.

Pure quartz, as it exists in transparent rock-crystal, is composed of silix or silicious earth, with two or three per cent. of water.

Silix is perfectly white, without either taste or smell. It feels harsh; is insoluble in any of the mineral acids; infusible alone, but melts and forms glass with potash. It is a compound body, and according to Berzelius, is composed of about 50 per cent. of oxygen, united to an equal proportion of its base, called silicium.

#### *Species 1.* COMMON QUARTZ.

*External characters.* Colours, white, yellowish, red, bluish, brown, and greenish, or green, or transparent and colourless; occurs massive; in concretions, with a diverging and acicular structure; in confused crystalline masses, of which the structure is not visible: also in crystals; form, the six-sided prism, terminated by six-sided pyramids: also the dodecahedron, or double six-sided pyramid. Both forms subject to a great variety of modifications; scratches glass; sp. gr. 2.65.

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Of what earth is quartz chiefly composed?—What are its colours?

**Chemical characters.** Infusible. Two pieces rubbed together give a peculiar smell, like that of the electric fluid ; insoluble in the acids, except the fluoric.

**Composition.** Silica nearly pure.—*Berzelius*.

**Subspecies 1. CRYSTALLIZED QUARTZ.**

General characters as in the species. Common form of the crystals, six-sided prisms, terminated by six-sided pyramids. Primitive form, the rhomboid.

Fig. 91.



Fig. 91. The six-sided prism, terminated by six-sided pyramids.

Fig. 92.

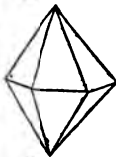


Fig. 92. The dodecahedron, or two six-sided pyramids, joined base to base, without the intervention of the prism.

Fig. 93.

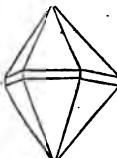


Fig. 93. The two pyramids separated from each other by the intervention of a very short six-sided prism.

Fig. 94.



Fig. 94. An irregular crystal, three planes of the pyramid being extended at the expense of the others ; a form not uncommon.

In figure 91, the terminating pyramids may be considered as separated several inches from each other, by the interven-

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What are its chemical characters ?—What are crystalline forms of quartz ?



ing prism, or as a prism several inches long, terminated by pyramids.

In figure 93, the pyramids are merely separated by the short prism interposed between their bases. This form, however, is still considered as a prism, terminated by pyramids.

In figure 92, the prism entirely disappears, and the two terminal pyramids join base to base. It now assumes a figure of twelve sides, each end beginning and terminating a six-sided pyramid.

These crystals are subject to a variety of modifications, by truncation, or the replacement of their edges, or solid angles, by plane faces of various sizes and shapes.

Crystallized quartz, not only occurs in single distinct crystals, but is often found implanted in groups, the pyramids of which only appear distinct. It also occurs lining the cavities of other minerals, or incrusting their surfaces in small, but frequently in very perfect crystals, the pyramidal terminations having a high polish, and the specimen appearing as if it was studded with gems.

Quartz occurs in primitive, transitive, and secondary rocks.

*Localities.* Madagascar, Dauphiny, the Alps, Cornwall, &c.

The finest crystals come from Madagascar and the Alps.

Specimens sometimes contain water, air, or bitumen enclosed. These are rare.

Crystals often enclose clay, titanite, hornblende, asbestos, iron ore, native silver, &c.

According to Pinkerton, nature produces regular rock crystals in the vast caverns of the Alps, of such enormous size, that they weigh several tons each.

U. S. The localities of rock crystal are very numerous in this country. A few, only where fine specimens are found, can be given.

Lake George, N. Y. The crystals are perfectly transparent, and sometimes 5 inches long.—*Silliman*. Frederic county, Md. The crystals are scattered on the surface of the ground, and are perfectly transparent.—*Hayden*. Grafton, Vt. Remarkably pure and translucent.—*Hall*. Newbury District, S. C.; Abington and Plainfield, Mass.

*Uses.*—It is much used, when cut and polished, as an inferior gem. The ancients made engravings upon it, but it is considered too soft for this purpose. The transparent variety

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Where are the finest specimens of quartz found?—What are the uses of quartz?

is polished for spectacles, and has the advantage of not being easily scratched.

Crystals may be coloured by plunging them while hot into a vegetable, or metallic solution which possesses colour, but they are very apt to crack by the process.

Quartz when set, may be distinguished from glass, or paste, by touching it with a fine file, which will cut the glass, but will not scratch the quartz.

The varieties of this species are numerous, and are distinguished chiefly by their colours.

*Variety 1. AVANTURINE.*

*External characters.*—Colours, brown, yellow, grey, bluish, greenish, or white; variegated by brilliant points or spangles, of a golden or silver colour.

These spangles are small plates of mica, of various colours, interspersed through the mass. It is employed in jewelry, and some specimens are exceedingly beautiful. It is sometimes imitated by art, apparently, by sprinkling recent brass filings into melted glass.

*Localities.*—Cape de Gatte, Spain. This is of the finest kind. Scotland, England, France, &c.

*Uses.*—It is much esteemed in jewelry.

*Variety 2. PRASE. GREEN QUARTZ.*

*External characters.*—Colour, dark green; occurs in crystals, and crystalline masses; lustre resinous, or vitreous; translucent.

It is seldom crystallized, but is commonly found in pebbles, or masses among other minerals.

It seems to be common quartz coloured with actynolite, or perhaps epidote. Sometimes the fibres of the actynolite are distinct.

*Localities.* Saxony in a metallic bed. Scotland with actynolite. Moravia, England, &c.

U. S. On Lake Superior. Near Baltimore, and on the west side of Blue Ridge, Md. Milton, Brighton, and West Cambridge, Mass.

*Use.* It is much esteemed as an ornamental stone, and is cut and polished for jewelry.

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What is the colour and appearance of aventurine?—What is the colour of prase?—How does prase differ from common quartz?

**Variety 3. MILKY QUARTZ.**

*External characters.*—Colour, milk-white; occurs massive and in crystals; hardness, that of quartz.

When crystallized, it is remarkable that the crystals are more regular in their forms than those of the transparent variety.—*Phillips*.

**Variety 4. ROSE QUARTZ.**

*External characters.*—Colour, rose-red, which in small pieces appears pale. Occurs massive and in crystals; translucent, or nearly transparent.

It fades, when exposed for a long time to the light. Its colour is probably owing to a small quantity of manganese.

*Localities.* Bavaria, Bohemia, Finland, Siberia.

U. S. Southbury, Con. It is of a delicate colour, and forms an insulated mass.—*Silliman*. Also at East-Haddam; Plainfield, and Williamsburg, Mass.; West-Chester, N. Y.; Keene and Acworth, N. H.

*Use.* It is cut and polished for jewelry.

**Variety 5. AMETHYST. VIOLET QUARTZ.**

*External characters.*—Colour, violet blue, often deep and pale in the same specimen; occurs most commonly in crystals; form the same as common quartz; crystals generally grouped, the pyramids only appearing distinct; translucent; hardness, that of quartz.

*Composition.* Silica 97.50; alumina 0.25; oxide of iron 0.50; oxide of manganese 0.25.—*Rose*.

Crystals of amethyst are rarely of the same colour throughout. The summits only, are commonly purple, the prism being colourless, or tinged greenish.

The Orientals were very partial to this stone. The colour, they considered that of new wine, and the Persians believed that wine drank from a cup of amethyst, would not intoxicate. The oriental amethyst is a sapphire, but it is probable that the present species was the one so highly esteemed, as the sapphire is found only in small crystals.

Crystals of amethyst very rarely occur single, but are faciculated, or aggregated, and separate into irregular columnar pieces, when struck.

By long exposure to heat, the colour is said to disappear.

It occurs in greenstone, and porphyry, often forming geodes. It is also sometimes found in primitive rocks.

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What is the colour of rose quartz?—Does it occur massive, or crystallized?—What is the colour of amethyst?

**Uses.** It is highly valued as an ornamental stone, and is cut and set for ear rings, necklaces, watch seals, &c. at the present day.

The name Amethyst occurs in Scripture. It was the ninth stone in order, on the Jewish high priest's breast-plate of judgment, with the name Issachar engraved thereon.

Some of the finest engravings are on this stone. Among these are the bust of Trajan in the Royal Library at Paris; and more recently done, are the Apollo Belvidere, the Farnese Hercules, and the group of Laocoon, by *Sirleti*.

**Localities.** Cambay in India, Siberia, Spain, Sweden, Bohemia, France, England, &c.

The finest are brought from India, Spain, and Siberia.

U. S. Wallingford, Farmington, Berlin, and East-Haven, Conn.—*Cleaveland*. Mount Tom, Mass. in beautiful crystals. *Silliman*. Ludlow and Westminster, Vt. Pacquanack Mountain, and at Patterson, N. J. Chester County, Penn. in large transparent crystals.—*Gilmor*. Hampton Falls, and White Hills, N. H. Belchertown, Mass. in rounded masses, sometimes 18 inches in diameter.—*Shepard*.

**Variety 6.—YELLOW QUARTZ. CITRINE.**

**External characters.**—Colour, wine, honey, or straw yellow; occurs massive and in crystals; translucent; semi-transparent.

When heated, its colour entirely disappears in a few seconds. It is called false, or Bohemia topaz.

**Localities.** Carngorm, Scot.; Cornwall, Eng.

U. S. Southampton, Mass. Near St. Louis, on the banks of the Mississippi. Blue Ridge, Penn. Acworth, N. H.

**Distinctive characters.**—The topaz, for which citrine is often mistaken, scratches quartz, which citrine does not.

**Variety 7. BROWN QUARTZ.**

**External characters.** Colour, various shades of brown, translucent.

**Localities.** Jetland furnishes the finest crystals of this variety.

**Variety 8. FERRUGINOUS QUARTZ.**

**External characters.** Colour yellowish, or reddish, sometimes blood, or brownish red; occurs massive and crystallized in the usual form of quartz; translucent or opaque; fracture small conchoidal.

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What use is made of amethyst?—What is said of the occurrence of this name in the Scriptures?

*Chemical characters.* Some specimens become magnetic when heated.

*Composition.* Silice 93.5; oxide of iron 5.0; water 1.0.—*Bucholz.*

The massive variety is sometimes crystallized on the surface; and sometimes groups of common white crystals terminate in ferruginous quartz, the summits only being coloured.

This variety of quartz is coloured by the oxide of iron: hence when the yellowish kinds are exposed to heat, oxygen is absorbed, and the colour is changed to red.

Ferruginous quartz is most commonly found in primitive mountains, associated with the ores of iron.

*Localities.* Bohemia, Spain, England, Scotland, Siberia, and Saxony,

U. S. Litchfield, Conn. At Mentzer's Gap, Penn. in loose masses, terminated at each extremity by three faces.—*Hayden.*

#### *Variety 9. IRISED QUARTZ.*

This variety is peculiar only for reflecting a series of prismatic colours, either internally, or externally. When the reflection is external, it probably proceeds from the deposit of some metallic oxide on the quartz. The internal colours obviously proceed from cracks, or fissures, which are sometimes in the direction of the natural joints.

Sometimes the internal play of colours may be produced, by plunging a crystal, moderately heated, into cold water.

#### *Variety 10. RADIATED QUARTZ.*

It occurs in crystals generally small, and closely aggregated, which radiate from a point.

#### *Variety 11. STALACTICAL QUARTZ.*

This variety, according to Phillips, occurs in one of the Cornwall copper mines. It has, in no respect, the appearance of chalcedony, since it consists of stria stalactites several inches long, composed of an aggregation of crystals diverging from the centre.

A beautiful specimen of this variety in my possession from South America, is studded at every point externally, with small brilliant crystals. Internally, and particularly near the surface, it is composed of aggregated, radiating crystals. Colour, milk-white.



*Variety 12. PSEUDOMORPHOUS QUARTZ.*

This variety either takes the forms of crystals, or of cavities once occupied by crystals.

These specimens sometimes present very curious appearances, viz. : hollow vacant spaces, of the exact form of some crystal which the quartz had once invested, but which had been decomposed and washed away. Also, the solid form of some crystal, under which real crystals of quartz never appear, and which form it took from the deposition of quartz into the cavity once occupied by some real crystal.

*Localities.* Bristol, Cornwall, and Durham, Eng.

U. S. Southampton and Deerfield, Mass. Simsbury, Conn.

*Variety 13. FETID QUARTZ.*

*External characters.* Colour, grey, of several shades, sometimes marked with spots or stripes of a dark hue ; occurs massive, and sometimes in crystals ; translucent ; lustre resinous ; gives a fetid odour when struck.

According to Professor Cleaveland, this variety, never transparent, is always translucent or opaque, and in some instances phosphoresces by friction.

The odour which it emits is like that of sulphuretted hydrogen, and probably arises from some bituminous matter, which at the same time gives it colour.

*Localities.* Near Nantes, in France.

U. S. Topsham, Me. On the banks of Connecticut river, from Bellows Falls to Middletown.—*Hitchcock.*

*Variety 14. SPONGIFORM QUARTZ.*

*External characters.*—Colour, white, yellowish, or greyish white ; occurs massive ; texture loose and spongy ; easily broken ; very light ; scratches glass ; floats on water for a few minutes.

*Composition.* Silice, 98 ; carbonate of Lime, 2.—*Vauquelin.*

Professor Mohs says, that float-stone consists of a delicate tissue of minute crystals, visible under a powerful magnifier, and that it insensibly passes into hornstone and flint.

*Variety 15. GRANULAR QUARTZ.*

*External characters.* Colour, white, or greyish white ; occurs massive ; structure, fine granular ; often friable ; sometimes flexible ; opaque.

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What is pseudomorphous quartz ? How is fetid quartz distinguished ?  
What is said of spongiform-quartz ?

The appearance of this variety resembles a white sandstone without cement. In thin plates it is sometimes slightly flexible.

It sometimes forms extensive beds.

*Localities.* Brazil and near St. Gothard. Whitby, Eng. The flexible kind occurs at all these localities.

U. S. Vernon and Middlebury, Vt. Williamstown, Mass. where it forms a hill.

#### *Variety 16. SMOKY QUARTZ.*

*External characters.* Colour, brownish yellow, of various shades; translucent, or nearly transparent.

Objects seen through it appear as they do through smoked glass.

*Localities.* Cairngorm, Scot. and Brazil.

U. S. • White Hills, N. H. Shrewsbury and Wardsborough, Ver. Lancaster county, Penn. Fine crystals.—*Seybert.* Cornwall, and Torrington, Conn. Topsham, Me. Acworth, N. H. Fine specimens.

*Uses.* It is employed in jewelry. Some very ancient engravings are said to be on this kind of stone.

#### *Species 2. CAT'S EYE.*

*External characters.* Colour grey, with a greenish tinge; also brown or reddish; gives out internal white chatoyant reflections of light, sometimes greenish and pearly, resembling the reflection from the eye of the cat; translucent in one direction, and nearly transparent in another; scratches quartz.

*Chemical characters.* Infusible, but becomes opaque and spotted, by heat.

*Composition.* Silica, 95; alumina, 1.75; lime, 1.50; oxide of iron, 0.25.—*Klaproth.*

This is a singular and beautiful little stone, which comes from India, ready cut and polished. The size is about that of half a hazelnut, and it is generally cut in form of an ovate hemisphere. Its peculiar pearly reflections are said to be caused by minute fibres of amianthus, by which it is penetrated.

It is in great request as a gem, and bears a high price.

Its geological situation and localities are unknown.

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What is the appearance of smoky quartz?—What peculiarity has cat's eye?—What is the cause of the pearly reflections in this stone?

*Species 3. OPAL.\**

This species contains one of the most beautiful and costly of precious stones. The composition of opal differs from that of quartz, chiefly in its containing a greater quantity of water. None of the varieties are hard enough to give fire with steel.

*Variety. 1. PRECIOUS OPAL. NOBLE OPAL.*

*External characters.* Colours, white, milk white, or yellowish white; occurs in small masses, or concretions; translucent, or transparent; presents as it is turned in different directions towards the light, most of the prismatic colours; fracture conchoidal; scratches glass; easily broken; sp. gr. 2.1.

*Chemical characters.* Decrepitates and loses its colours when heated, but is infusible.

*Composition.* Silica 90; water 10.—*Klaproth.*

The precious opal is readily known from its beautiful display of changeable colours; these are green, blue, yellow, red, and purple of various shades, proceeding from the interior of the gem, and depending on the direction in which it is turned towards the light.

The phenomenon of this beautiful play of colours, has not been satisfactorily explained. Haüy attributes it to the fissures of the interior being filled with films of air, agreeably to the law of Newton's coloured rings, when two pieces of glass are pressed together.

Mohs objects to this explanation, on the ground that, were this the fact, the opal would present nothing but a kind of iridescence.

Dr. Brewster, however, after a great number of observations, concludes that the play of light depends upon openings in the interior of the mass of opal, which are not accidental fissures, but of a uniform shape, and which reflect the tints of Newton's scale.

The opal was well known to the ancients, and is mentioned by Pliny, who states that the Roman Senator Nonius chose to suffer banishment, rather than part with a valuable one to Mark Anthony.

*Localities.* Hungary; where it is found in small masses,

\* From the Greek, signifying eye. The ancients believed this stone had the power of strengthening the eye?

What is the composition of precious opal?—How may this gem be distinguished?—What causes its variety of colours?



in a vein of claystone porphyry. Also in the Faroe Islands; near Freyberg, and in South America.

The Hungarian opal mines are at Czerwiniza, where they are found of various qualities, from the white translucent common opal, to the utmost refulgence of the lively play of colours by which that noble gem is distinguished.

*Uses.* The opal is cut and polished for the finest and most costly kind of jewelry. In setting it, a black foil is said to have a powerful effect in heightening its play of colours. Some opals of remarkable beauty, are equal in value to the diamond.

Jameson relates that in the cabinet at Vienna, there are two pieces of opal, one of which is 5 1.2 inches long, by 2 1.2 inches in diameter, and the other about the size of a hen's egg. Both of them exhibit a very rich and resplendent play of colours. These are from Hungary, and probably the largest specimens ever found.

#### *Variety 2. FIRE OPAL.*

*External characters.* This variety differs from the precious opal in possessing only a red reflection, when turned toward the sun, or a strong light.

The colour of fire opal is bluish white, milk white, or yellowish. It is said to occur with the precious opal, but to be much more rare.

Jameson describes a fire opal of a hyacinth red which gives carmine red and greenish reflections. It comes from Mexico.

Mr. Phillips possesses a specimen of fire opal from Cornwall.

#### *Variety 3. COMMON OPAL.*

*External characters.* Colour, white, with shades of yellow, blue, or green; occurs massive, and in rolled pieces; fracture perfectly conchoidal; fragments sharp edged; lustre resinovitreous; translucent; is scratched by quartz; brittle; scratches glass; sp. gr. 2. 1.

*Chemical characters.* Infusible; insoluble in acids.

*Composition.* Silica 92; water 7.75; oxide of iron 0.25.—*Phillips.*

This variety is entirely without the play of prismatic colours which makes the precious opal so valuable.

When viewed by the transmitted light, the milk white variety often appears of a different colour.

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What is the use of this stone?—How does the common, differ from the precious opal?

*Distinctive characters.* Pitchstone, which it may sometimes resemble, is fusible, and of a darker colour. Its fracture is more perfectly conchoidal, and it is more translucent than semi-opal. It is not as hard as chalcedony, cacholong, or hornstone.

*Localities.* Hungary, Saxony, Bohemia, and Silesia. In Hungary it is found with the precious opal.

U. S. Near Easton, Penn. Litchfield, Conn.

*Uses.* It is cut and polished for jewelry.

Some fine ancient engravings are on this stone, but it is considered too soft for this purpose. Of modern engravings on it, a cameo is mentioned, bearing the likeness of Louis XIII. when a child.

#### Variety 4. SEMI-OPAL.

*External characters.* Colours, white, greyish, yellowish, or brownish; occurs in compact masses, also stalactical and reniform; fracture imperfectly conchoidal; translucent, or nearly opaque; colours generally dull, and sometimes runs in spots or veins; brittle; often covered with an opaque crust from decomposition.

*Chemical character.* Infusible, but turns white.

*Composition.* Silica 85; carbon 1; ammoniacal water 8; oxide of iron 1.75.—*Klaproth.*

*Distinctive characters.* It is more opaque than common opal; and is also harder. Pitchstone is generally of a darker colour, and is fusible. It never possesses the peculiar milky whiteness of cacholong, nor the hardness of chalcedony.

It occurs in most countries of Europe, especially in silver veins, traversing granite and gneiss.

*Localities.* Greenland, Iceland, Faroe Isles, and France.

U. S. Bare Hills, Md. Corlear's hook, N. Y. At the Falls of the Delaware, Penn.

#### Variety 5. WOOD OPAL.

*External characters.* Colour, several tints of white, grey, brown, and black; occurs massive, with a ligneous aspect; fracture conchoidal; harder than semi-opal; lustre resinous or waxy; translucent on the edges, or opaque; sp. gr. 2.

This variety resembles semi-opal, except in its woody appearance.

It is distinguished, according to Phillips, from petrified

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What is the use of common opal?—What are the distinctive characters of common opal?

wood, by its greater lightness and translucency and its conchoidal fracture.

*Localities.* Hungary, in alluvium. Transylvania, in trap.

*Variety 6.* FERRUGINOUS OPAL.

*External characters.* Colour, some shade of red, yellow, grey, or brown, generally deep, sometimes spotted; occurs massive; opaque or feebly translucent at the edges; fracture flat conchoidal; lustre shining: sp. gr. 2.

*Composition.* Silica 43.5; oxide of iron 47; water 7.5.

*Distinctive characters.* Differs externally from common opal in the deepness of its colours. It probably passes into jasper, from which it is sometimes difficult to distinguish it.

*Localities.* Hungary, Siberia, Saxony, and near Constantinople.

*Variety 7.* HYDROPHANE.\*

*External characters.* Colours, white, or yellowish; occurs massive, and in small concretions; opaque, when dry, but becomes translucent and opalescent after immersion in water; adheres to the tongue; fracture conchoidal.

*Composition.* Silica 93.13; water 5.25; alumina 1.62.—*Klaproth.*

The curious property which this variety possesses of becoming transparent, on immersion, seems to depend on the porous nature of the stone. Other porous substances, containing air, as white paper and linen, become more or less transparent when their pores are filled with water instead of air.

Winklemann describes an ancient engraved stone, with three layers, one of which was white; and says that the white layer became black, when the ring in which it was set was worn, but that it became white again when the ring was laid aside.

It is probable that the white layer, was an *hydrophane*, and that the moisture of the hand rendered it so transparent as to show the black one to which it was attached, through it, and thus to make itself appear black.—*Rees Cyclop.*

*Species 4.* FLINT.

*External characters.* Colours, grey, yellow, and blackish, of various shades; occurs in nodular masses, covered exter-

\* From the Greek, in allusion to its becoming transparent in water.

What are the colours of hydrophane?—Whence comes the name of this variety?—How is the transparency of this stone accounted for when immersed in water?

nally with a white chalky coat; texture compact; fracture perfectly conchoidal; lustre glimmering, somewhat greasy; fragments sharp edged; translucent on the edges; gives lively and copious sparks with steel; scratches quartz: sp. gr. 2.58 to 2.63.

*Chemical characters.* Infusible, but loses its colour, and becomes opaque and brittle.

*Composition.* Silica 98; lime 0.5; alumina 0.25; oxide of iron 0.25; water 1.—*Klaproth.*

It is found in the upper part of chalk formations, in marl, in limestone formations, and in alluvial deposits.

*Localities.* Denmark, Poland, Siberia, France, England. Immense beds are found in the north of France, and at Dover, in England.

Nodules of flint are sometimes found enclosing organic remains, and Kirwan quotes an author who says that 126 silver coins were found in different nodules of flint at Grinoc, in Denmark, and an iron nail, at Potsham.

*Uses.* Its most important use is that of making gun-flints. It therefore assumes a very important rank among minerals, and particularly when it is considered that the defence, and even liberty of a nation may depend on its locality.

The manufacture of gun flints is chiefly confined to France and England. In the former country, in the vallies of the Seine and Marne, immense beds of flints are found, and the manufacture is carried on to a great extent.

Good stones for this purpose are however comparatively scarce, for Dolomieu states, that out of 20 beds, which the workmen go through, not more than one or two, contain good flints for working. Nor can the stones, though good when first raised, be worked after being exposed to the air for any considerable time.

The instruments used in fashioning gun flints are, a large hammer with square heads; a small hammer with blunt points, nearly in the form of a triangle; a little steel instrument, in shape of a wheel, with a handle in the centre, called a roller; and a chisel seven or eight inches long, bevelled on both sides.

Having selected a good specimen of silica, the workman seats himself on the ground and proceeds as follows.

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How does flint differ from other species of quartz?—What are the uses of flint?

Placing the mass on the left thigh, he divides it in the middle with a few gentle blows of the large hammer.

He next takes one half of the mass, and with the small hammer, breaks it into pieces about  $2\frac{1}{2}$  inches long,  $1\frac{1}{2}$  wide, and  $\frac{1}{4}$  of an inch thick. This requires peculiar dexterity and much experience.

To fashion the flint; he places one of the small pieces on the edge of the chisel, which is supported by the fore-finger of the left hand, and with light blows of the roller, it breaks along the edge of the chisel, and is thus reduced to its proper shape and size.

The operation of fashioning a gun flint is done in less than a minute, and a good workman will produce a thousand per day.

About 800 people are employed in this species of manufacture, in a particular section of France, and they have excavated a great proportion of the plain they inhabit.

*Species 5. CHALCEDONY.\**

This species presents several varieties which nearly agree in respect to fracture and hardness, but differ chiefly in respect to colour. In several instances, however, they mutually pass into each other, so that it is sometimes difficult to determine where one variety terminates and the other begins. Chalcedony also passes insensibly into agate and carnelian, and perhaps into hornstone.

*Variety 1. COMMON CHALCEDONY.*

*External characters.* Colours, white, bluish white, pale yellow, brownish, greenish, and grey; occurs in small masses, in nodules, stalactical concretions, and in hollow crusts; surface rough; fracture conchoidal, or uneven; fragments sharp edged; lustre vitreous; harder than flint; translucent, with a cloudy, or milky appearance: sp. gr. 2.60.

*Chemical characters.* Infusible, but turns white and opaque.

*Composition.* Silica 84; alumina 16.—*Bergman.*

Chalcedony when viewed by transmitted light, appears milky, and sometimes clouded.

It almost always occurs externally with a dark coloured, corroded crust, and is often found hollow, with crystals of quartz lining its cavities.

\* From Chalcedon in Asia, where it was found by the ancients.

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How are the nodules of this stone formed into gun flints?—Whence comes the name, chalcedony?—What is chalcedony composed of?—In what form does this mineral chiefly occur?



*Distinctive characters.* It is more transparent than flint ; is never reddish like carnelian ; nor milk white and opaque, like cacholong ; nor striped, like onyx and agate. It also differs from all these in exhibiting marks of internal mammillary concretions, when held between the eye and the light.

Chalcedony is often called by jewellers, white carnelian.

It is found in the cavities of rocks, as amygdaloid, porphyry, green-stone, and basalt.

*Localities.* Its foreign localities are very numerous, but the finest specimens are said to be found in Cornwall, Eng. and the Faroe Islands.

U. S. East Haven, Con. ; specimens fine, and well characterized.—*Silliman.* Deerfield and Middlefield, Mass. ; Counties of Perry, Athens, Hocking, &c. Ohio—*Atwater.* Little Britain, Lancaster County, Penn. ; very beautiful.—*Conrad.* Several places in Missouri. Near Pompton Plain, also on Pracknes Mountain, and in Sussex County, N. J. ; Lynn, on Nahant beach, Mass.

*Uses.* Chalcedony bears a fine polish, and is considerably esteemed, under the name of white carnelian, as an ornamental stone, for watch seals, snuff boxes, &c.

The ancients engraved upon it, and there are still extant, several master pieces of the art, on this stone. One of the best is the celebrated Dionysian bull, by *Hyllus*.

#### *Variety 2. ONYX.*

*External characters.* Colours, milk white and opaque, and bluish white and translucent, alternating with each other.

The onyx, so far as we have been able to ascertain, is a striped chalcedonic stone, consisting of alternate layers of opaque milk white chalcedony, or cacholong, and of the common bluish, translucent chalcedony.

Good specimens of the onyx may often be found at the present time among the obsolete, and neglected articles which are thrown aside in every jeweller's shop.

#### *Variety 3. CACHOLONG.*

*External characters.* Colour, milk white ; occurs in layers with chalcedony ; or sometimes encrusting or penetrating it ; opaque, or as it runs into chalcedony, translucent ; hardness equal to quartz ; lustre pearly : subject to disintegration.

This is merely a white and opaque variety of chalcedony,

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Is it a common mineral ?—What are its uses ?—What is the appearance of onyx ?

into which it passes by insensible shades. In polished specimens of chalcedony, specks of cacholong are often seen.

*Localities.* On the borders of the river Cach,\* in Bucharia, with chalcedony. In the Faroe Island, Elba, Spain, &c.

U. S. Deerfield, Mass. (with chalcedony). Pittsfield, Mass.

*Variety 4. SARD.*

This is chalcedony of a deep rich, reddish brown colour; by transmitted light approaching to blood red.—*Phillips*.

This is most probably a variety of carnelian, but is permitted to remain here, that the varieties forming the sardonyx may be near each other.

*Species 6. SARDONYX. Rees' Cyclop.*

*External characters.* Colours, alternately bluish, white, and red; consisting of stripes or layers of onyx and sard.

Systematic writers do not agree as to what constitutes onyx and sardonyx.

*Jameson* says, the onyx is formed of white and brown stripes of chalcedony.

*Aiken* thinks, that two or more plates of any of the varieties of chalcedony forms the onyx.

*Hauy* and *Cleveland* call that variety of agate, on which the different colours are arranged in distinct parallel stripes or zones, onyx-agate.

*Phillips* agrees with *Jameson* in respect to onyx, and says that sardonyx consists of sard and alternate layers of onyx, or milk white chalcedony.

*Hauy* and *Cleveland*, define sardonyx, to be a reddish yellow variety of chalcedony, &c.

Amidst this confusion, it appeared desirable that the ancient distinctions should be adopted, if they could be ascertained, and it appears from *Rees' Cyclop.* article Gems, that the stone anciently called onyx, was one which agreed with the above description of that variety, and that the sardonyx consisted of alternate stripes of sard and onyx, or sard and chalcedony, or both.

This account agrees with that of *Calmet*, who says that sardonyx is sardius united to onyx.

Onyx and sardonyx have been employed by ancient, as well as modern artists, for executing those gems in relief, called Cameos; the different colours enabling the artist to display his taste and skill with most exquisite effect. Thus if a white

\* Cach, whence the name.

translucent zone be next to one of sard, the red ground will impart a beautiful flesh-red colour to the face, and if a white opaque zone comes next above the translucent one, as in the onyx, this may be converted into drapery, &c.

Many celebrated productions of this kind are still preserved, and among them there are in the Royal Library at Paris, the following. The Apotheosis of Augustus, of two brown and two white layers, being an oval of eleven inches by nine. The celebrated Brunswick Vase, representing Ceres in search of Proserpine. Agrippina and her two children, the stone consisting of two layers, brown and white. The quarrel of Minerva with Neptune, three layers. Venus on a sea-horse, surrounded by cupids, the layers being black and white; see *Rees' Cyclopaedia*.

*Species 7. HELIOTROPE.\* BLOODSTONE.*

*External characters.* Colour deep green, peculiarly rich and pleasant to the eye, interspersed with blood red, or yellowish spots, or dots; fracture conchoidal; translucent on the edges; lustre glistening and resinous: sp. gr. 2.63.

*Chemical characters.* Infusible, but loses its colour.

*Composition.* Silice 84; alumine 7.5; oxide of iron 5.—*Thomson*.

*Distinctive characters.* It differs from jasper by its translucency, and from this and most other minerals by the richness and peculiarity of its colours.

It is called bloodstone from the appearance of the red spots, and sometimes oriental jasper, because the finest varieties come from the east. These spots appear to be fine red jasper.

*Localities.* Siberia, Iceland, Bohemia, Faroe Islands, Scotland, and India.

U. S. Near Troy, N. Y.—*C. U. Shepard*.

*Uses.* Fine specimens are highly esteemed as an ornamental stone, for seals, snuff-boxes, rings, &c.

Artists who have engraved on this stone, have sometimes availed themselves of its peculiar arrangement of colours to produce striking effects. Thus there exists in the royal collection at Paris, a bust of Christ on a heliotrope, in which the drops of blood are represented by the natural red spots on the stone.

\* From two Greek words signifying, spotted with suns.

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How are cameos formed?—Why is the heliotrope called blood stone



*Variety 1. PLASMA.\**

*External Characters.* Colour, green, with yellow white spots; fracture conchoidal; lustre feebly resin translucent: harder than quartz.

*Chemical characters.* Infusible, but becomes whitish opaque.

*Composition.* Silica 98.75; alumina 0.25; iron 0.5.—*roth.*

*Distinctive characters.* The green is not so rich, and faint, as that of heliotrope. It is darker than chrysoprase; its translucency will distinguish it from jasper.

*Localities.* Italy and the Levant; Moravia, Mount Vesuvius, Prussia, and South America.

It was worn as an ornamental stone by the Romans, still esteemed.

*Variety 2. CHRYSOPRASE.†*

*External characters.* Colour, apple green; occurs in masses; fracture conchoidal; translucent, lustre glimmering; hardness a little less than that of flint: sp. gr. 3.

*Chemical characters.* Infusible, but becomes opaque white.

*Composition.* Silica 96.17; lime 0.83; alumina 0.08 of iron 0.08; oxide of nickel 1.0.—*Klaproth.*

*Distinctive characters.* Its colour is a little lighter and livelier than those of heliotrope or plasma, and it is free from spots. The lustre of prase is vitreous, and its fracture is conchoidal and quartose.

*Localities.* Lower Siberia, in veins with chalcedony; U. S. Newfane, N. H.; colour apple green, amorphous.

*Uses.* It is highly prized as a gem; ringstones of the finest quality, being sometimes sold for 20 guineas. Its high price has produced excellent imitations in paste.

*Species 8. CARNELIAN.‡*

*External characters.* Colours, red of different shades, from light flesh red, to dark blood red, passing into greenish and bright yellow; fracture perfectly conchoidal; glimmering; translucent or semi-transparent; occurs in rounded masses, also reniform and in thin plates.

\* Plasma, Greek; engraving; because the ancients engraved.

† From the Greek, a superior kind of prase.

‡ From its resemblance to the colour of flesh.

What is the colour of chrysoprase?—What is its use?—  
comes the name carnelian?

*Chemical characters.* Infusible, but turns opaque and loses its colour.

*Composition.* Silica 94; alumina 3.5; lime 1.5; oxide of iron 0.75.—*Bindheim.*

*Distinctive characters.* Carnelian can only be distinguished by its colours, and in some specimens it is difficult to decide whether it belongs to chalcedony, agate, jasper, or carnelian. Indeed, in many specimens all these varieties are blended together, and insensibly pass into each other. Specimens properly called carnelian, are often spotted with opaque jasper, striped, or clouded with cacholong, &c.

In making carnelian a species, convenience to the learner has been consulted, rather than the dictates of authority.

It is found with chalcedony, agate, and jasper.

*Localities.* India, Arabia, Siberia, and almost every other country. The finest comes from India.

U. S. Near Lake Superior. At the Falls of St. Anthony, and at Herculanum, Missouri. Deerfield, Mass.

*Uses.* Some of the finest specimens of antique engraving, are on carnelian, and the purest and most transparent stones of this kind, are still found among these remains of ancient art. Hence it has been supposed that the ancients possessed the art of improving the beauty of their carnelians, by some process now unknown.

The number of ancient engraved carnelians still preserved, is very numerous, and hence it is inferred that this stone was preferred to all others for this purpose.

#### *Species 9. AGATE.*

*External characters.* Agate is an aggregate of a variety of silicious substances, each of which maintains, more or less, its own character and colour in the mass. The minerals of which agate is composed, are chalcedony, cacholong, quartz, amethyst, carnelian, heliotrope, jasper and common opal.

In general, only two or three of these minerals are present in a single specimen, and occasionally specimens of agate occur mostly composed of chalcedony, which generally, indeed, is the principal ingredient.

The variety of colours which the agate presents, depends chiefly on the number and kind of the simple minerals which compose it. Some specimens are dotted or clouded with red carnelian; or striped like the onyx, alternately with chalce-

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Where is carnelian found?—Is it a common stone?—How does agate differ from carnelian?—How is agate formed?

dony and cacholong ; or in some parts opake, with the presence of jasper, &c. The varieties depend on the arrangement of the colours.

*Variety 1. RIBBON AGATE.*

It consists of parallel layers of several simple minerals, as chalcedony, cacholong, jasper, &c. alternating with each other.

*Variety 2. BRECCIATED AGATE.*

This beautiful variety is composed of the angular fragments of other varieties, united into masses by a silicious cement.

*Locality.* Saxony, in a metallic vein.

*Variety 3. FORTIFICATION AGATE.*

It consists of a centre of one colour, for instance of red carnelian, surrounded by zigzag angular lines of other colours, as of white cacholong, chalcedony, &c ; the whole resembling, with the help of the imagination, a fortification.

*Variety 4. MOCHA-STONE. MOSS AGATE.*

It is formed of a translucent exterior, with internal appearances like vegetable fibres, as roots, moss, or trees. These perhaps were once real vegetables, changed to stone by the infiltration of silicious particles.

Dr. Mac Cullock, as stated by Mr. Phillips, has instituted an inquiry into the nature of the vegetable appearances in the varieties of agate, and from which he concludes that they are owing to the existence of real plants in the stone.

Agates are found in porphyry, amygdaloid, greenstone, and serpentine, generally accompanied with chalcedony, carnelian, &c.

*Localities.* Oberstein, in Germany. Saxony, Silesia, Italy, Scotland ; also in many places in England, and most other countries.

The most beautiful are said to come from Oberstein, in Germany.

U. S. Near Baltimore, Md. In most of the greenstone hills, in New-Jersey. East-Haven, Conn. Also at Woodbury, Conn. Deerfield, Mass. composed of chalcedony, carnelian, sardonyx, and cacholong.—*Hitchcock.* Also, in Georgia, Missouri, and Indiana. Cumberland, R. I. beautiful.

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What are the principal varieties of agate ?

*Uses.* The hardness of agate, and the great variety and beauty of its colours, have brought it into extensive demand, both for useful and ornamental purposes. It is employed for mortars, snuff-boxes, seals, beads, &c.

The ancients employed it for engravings, and some fine cameos still exist on this stone.

*Species 10. JASPER.*

Jasper, like carnelian, chalcedony, and agate, is chiefly composed of silex; but it always contains a greater proportion of iron, and hence instead of being translucent, like these minerals, it is always opaque.

This species is subdivided into the following varieties.

*Variety 1. COMMON JASPER.*

*External characters.* Colours, red, yellow, and brown, of different shades, often variously intermixed; also, greenish, bluish, or nearly black, and sometimes white; occurs in amorphous masses of various dimensions; lustre dull, or slightly resinous; fracture conchoidal; entirely opaque: sp. gr. 2.70.

*Chemical characters.* Infusible, but turns whitish.

*Composition.* Silex 75; alumine 0.5; lime 0.02; iron 13.  
—*Kirwan.*

*Distinctive characters.* Jasper is distinguished from carnelian, heliotrope, hornstone and opal, by its opacity; jaspery iron ore is heavier than jasper, and blackens under the blow pipe; pitchstone is fusible.

*Variety 2. STRIPED JASPER. RIBBON JASPER.*

*External characters.* Colours, red, yellow, green, grey, or brown, arranged in stripes or bands, sometimes in spots or veins.

*Locality.* Beautiful specimens are found in the Uralian mountains.

*Variety 3. EGYPTIAN JASPER.*

*External characters.* Colours, brown, red, and yellow of various shades, the yellow often light, approaching to cream colour. These colours are arranged in irregular zones, or in spots, or dendritic delineations. It occurs in rounded or ovate masses, with a brownish or nearly black and rough external coat.

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What are the uses of agate?—What is jasper chiefly composed of?  
—How does jasper differ from carnelian?—What are the principal varieties of jasper?

This variety is well characterized by the globular shapes of the masses, and their dark, rough, exteriors.

*Localities.* It is found in vast abundance, in Egypt, between Grand Cairo and the Red Sea.

*Variety 4. PORCELAIN JASPER.*

*External characters.* Colours, grey, or bluish grey, mixed with red, or yellowish, bluish, and brick red, variously intermixed in spots, clouds, or dots; occurs massive; structure sometimes slaty; fracture imperfectly conchoidal; lustre glistening, with the aspect of certain *porcelains*; scratches glass; opaque; brittle; softer than the other varieties: sp. gr. 2.6.

*Chemical characters.* Fusible into a black scoria.

*Composition.* Silica 60.75; alumina 27.25; potash 3.66; magnesia 3.00; oxide of iron 2.50.—*Rose.*

It is found in the vicinity of coal mines, which have once been in a state of combustion; and is considered as shale altered by heat. In some specimens there are evident marks of vitrification.

*Localities.* Mount Brasset, in France; and at Madely, Dudley, and Staffordshire, in England.

*Variety 5. RUIN JASPER.*

*External characters.* Colours various, but generally the ground is some tint of brown, with different coloured delineations resembling ruined buildings; nearly or quite opaque.

When ground and polished, it is sometimes a very beautiful mineral.

*Species 11. HORNSTONE.*

*External characters.* Colour, greyish or yellowish white, also with shades of green, or brown; occurs in masses, nodules, and amorphous concretions; transparent, passing into nearly opaque; lustre glimmering and somewhat waxy: less hard than quartz; fracture conchoidal: sp. gr. 2.6.

*Chemical characters.* Infusible, but turns opaque.

*Composition.* Silica 71.3; alumina 15.3; protoxide of iron 9.3; and a trace of lime.—*Faraday.*

*Distinctive characters.* It resembles compact felspar, and petro silica, but these are both fusible. It is less hard than flint, and commonly of a higher colour. Jasper is opaque.

Hornstone is sometimes *pseudomorphous*.

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What is the composition of jasper?—What are the colours of hornstone?—What is its composition?



Wood-Hornstone, is wood petrified by hornstone. It has the form and texture of wood.

Hornstone is found in veins, in primitive mountains, also in nodules in limestone.

*Localities.* Bavaria, in limestone; Sweden, where it forms the basis of porphyry, and in most other countries.

U. S. Middlebury, Cornwall, Bridport, Orwell, and West-Haven, Ver. Near Saratoga Springs, N. Y. also in Albany county, at Bethlehem, and at Bern, N. Y. West side of the Blue Ridge, containing carbonate of copper, and near Baltimore, Md. West Goshen and Newlin, Penn.

*Species 14. JEFFERSONITE.\* Keating.*

*External characters.* Colour, dark olive green, passing into brown; occurs in crystalline masses; translucent on the edges; cleavage in several directions which appear to be incompatible with each other; streak light green; lustre on the planes of cleavage semi metallic, on the cross fracture resinous; hardness equal to fluor: sp. gr. 3.55.

*Chemical character.* Fusible into a black globule.

*Composition.* Silica 56; lime 15.1; alumina 0.2; protoxide of manganese 13.5; peroxide of iron 10; oxide of zinc 10.—*Keating.*

*Localities.* Franklin iron works, N. J. in small masses, imbedded in Franklinite.

*Species 15. JENITE.† YENITE.*

*External characters.* Colours, brown, or brownish black; occurs amorphous, and in prismatic crystals; form the four-sided prism, terminated by four-sided pyramids; sometimes the prism is rhombic; also in eight-sided prisms terminated by eight-sided pyramids, and in fibrous masses; structure foliated; lustre glistening and resinous, or somewhat metallic; opaque; scratches glass, and gives sparks with steel: sp. gr. about 4.

Fig. 95.



Figure 95. A four-sided prism, longitudinally striated, one of the common forms.

\* In honor of Pres. Jefferson.

† In commemoration of the battle of Jena.

Whence does Jeffersonite obtain its name?—What are the characters of jenite?

*Chemical characters.* Fusible into an opaque black globule, which is magnetic.

*Composition.* Silica 30; oxide of iron 57.5; lime 12.5.—*Vanquelin.*

*Distinctive characters.* Blende, which it resembles in colour, is infusible; hornblende, and epidote are of less specific gravity.

*Localities.* Elba, in two places, Siberia, and Norway. It is found with iron ore, augite, and epidote. It is a very rare mineral.

U. S. Chatham, Conn. First shown to be Jenite by Prof. Torrey, of New-York.

#### *Species 16. GARNET.*

The garnet family includes several species, which are composed of nearly the same elements, but in different proportions. All the varieties agree in occurring in dodecahedral crystals, when crystallized at all.

##### *Variety 1. PRECIOUS GARNET. ALMANDINE.*

*External characters.*—Colour, red, mixed more or less with violet or blue, sometimes blood, or cherry red; occurs in crystals; form the dodecahedron, with its varieties; crystals sometimes flattened into tables; also granular; structure imperfectly lamellar; lustre shining vitreous; fracture conchoidal; brittle; translucent, or nearly transparent; scratches quartz: sp. gr. 4.

*Chemical characters.* Fusible into a black globule which is often magnetic.

*Composition.* Silica 35.75; oxide of iron 36; alumina 27.25; oxide of manganese 0.25.—*Klaproth.*

*Distinctive characters.* Spinelle ruby, which it resembles in colour, is infusible; Titanite, which often closely resembles garnet, is by itself, infusible, and its crystalline form is different. Hyacinth and leucite are both infusible, the latter is white.

Almandine is found in primitive rocks, as granite and mica slate.

*Localities.* Pegu, Bohemia, Hungary, Piedmont, Siberia, Alps, &c.

The most beautiful come from Sirian, the capital of Pegu, and are called Sirian garnets.

U. S. Hanover, N. H. Bethel and Royalton, Ver. Goshen, Conn. Newlin, Penn.

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What are the colours of garnet?—How is garnet distinguished from spinelle ruby?

The precious garnet is cut and polished for jewelry, and is much worn at the present day for ringstones, breast-pins, &c.

When set, garnets are easily distinguished from spinels, and red sapphire, by their more intense colour, turpiness, and sombre aspect.

The garnet was highly esteemed by the ancients as an ornamental stone, under the name of *caruncula*. Some beautiful specimens of ancient skill on this stone, are still preserved. The Dog Sirius, engraved on the precious garnet, is said to be the greatest master-piece existing, in point of deep work and finish. It is in the collection of the Duke of Marlborough. Among the more modern works on this stone is a head of Louis XIII. preserved in the National Museum at Paris.

In Bohemia, garnets are obtained by a regular system of mining, and when cut and polished, constitute an article of commerce, by which an extensive class of people are maintained.

After the garnets are collected, they are passed through vessels pierced with apertures of different diameters, by which means they are sorted into six different sizes. Of the largest size it takes 32 to weigh an ounce : of the next about 40, 75, 110, 165, 256 and 400, to an ounce.

The art of cutting and boring these stones occupies a great number of men.

The boring is done with a diamond fixed to the end of a small rod of metal. The garnet being properly placed and fixed, it is bored by turning the diamond with a bow and string. A workman can pierce 150 per day.

The large pyrope garnets are cut and polished on a disc of sandstone with emery. Of these a workman will finish 30 per day.

This art is carried to very great perfection in Bohemia. In the town of Waldkirch, alone, there are no less than 24 mills, and 140 master-workmen, occupied in manufacturing this article of commerce.—*Rees' Cyclop.*

#### Variety 2. COMMON GARNET.

*External characters.* Colours, red, yellowish red, brownish red, or dark brown ; occurs crystallized and massive ; form the dodecahedron, with its modifications ; opaque, or feebly translucent ; structure lamellar, or granular ; fracture un-

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What was the precious garnet formerly called ?—Give some account of the method of cutting and polishing precious garnets in Bohemia—What are the colours and forms of the common garnet ?



even ; lustre glistening ; brittle ; less hard than the precious garnet : sp. gr. 3.69, to 3.76.

Fig. 96.

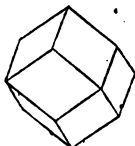


Fig. 97.

Fig. 96. The dodecahedron with rhombic faces which is the primitive form, and is the most common form under which the garnet appears.

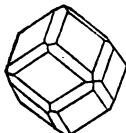


Fig. 98.

Fig. 97. The same, with the edges truncated.

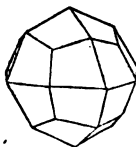


Fig. 98. A solid with twenty-four trapezoidal faces, forming the trapezoidal garnet, a form under which it sometimes appears.

The garnet sometimes has 36, 48, or even 60 faces.

*Chemical characters.* Fusible with more ease than the precious garnet, into a black, or greenish glass.

*Composition.* Silica 43 ; alumina 16 ; lime 20 ; oxide of iron 16.—*Vauquelin.*

It is a curious circumstance that the precious garnet should be nearly transparent, with almost 40 per cent. of iron, while the present variety is opaque, with only 16 per cent. of the same metal.

*Distinctive characters.* It differs from the precious garnet in being opaque, darker coloured, more easily fusible, and not so hard.

It is mostly found in primitive rocks.

*Localities.* The common garnet is found in almost every section of country where primitive rocks occur. Its foreign localities are too numerous to mention.

U. S. Haddam, Chatham, Bolton, and Washington, Conn. Newbury, Bedford, Plainfield, and Cummington, Ver. Interior of N. Carolina, as large as a child's head.—*Maclure.* Barren hills, Penn. in dodecahedrons with truncated edges,

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In what kind of rock is the common garnet found ?

sometimes five inches in diameter.—*Morton*. Brunswick and Topsham, Maine.

*Variety 3. PYROPE.*

*External characters.* Colour red, often dark blood red, with a tinge of yellow, by the transmitted light; occurs in rounded angular grains, but never in crystals; transparent, or translucent; lustre splendid; vitreous; fracture conchoidal; scratches quartz: sp. gr. 3.9.

*Chemical characters.* Fusible into a black glass; tinges borax green.

*Composition.* Silica 40; alumina 28.5; magnesia 10; oxide of iron and manganese 16.75.—*Klaproth*.

*Distinctive characters.* Differs from the other varieties, in never occurring in crystals. When polished, its yellowish tinge and greater transparency distinguishes it from almandine.

It is found in serpentine, and alluvial deposits.

*Localities.* Saxony, and Bohemia; also at Ely, in Scotland.

U. S. Chester county, Pa. Its colour is fine dark red.—*Lea*.

Werner considered the present variety as nearly allied to the pyrope of the ancients, mentioned by the same name by Pliny, and Ovid.

*Variety 4. GROSSULAR.\**

*External characters.* Colour, green, of several shades; occurs in crystals of the same form as common garnet; translucent; faces of the crystals smooth and shining: sp. gr. 3.37.

*Composition.* Silica 44; alumina 8.50; lime 33.50; oxide of iron 12.—*Klaproth*.

*Locality.* Siberia.

*Variety 5. APLOME.*

*External characters.* Colours, deep brown, or orange brown; occurs in rhombic dodecahedrons, the faces of which are striated parallel to their shorter diagonals; fracture uneven; scratches quartz; nearly opaque: sp. gr. 3.44.

*Chemical characters.* Fusible into a black glass.

\* French, Gooseberry, from its green colour?

What is pyrope?—What is grossular, and why is it so called?—What is aplome?

*Composition.* Silice 40; alumine 20; lime 14.5; oxide of iron 14.5; oxide of manganese 2.—*Laugier.*

*Distinctive characters.* The direction of its striae differs from those of common garnet, and its specific gravity is less; in other respects they are much alike.

*Localities.* Siberia, and probably in Saxony.

*Variety 6. MANGANESIAN GARNET.*

*External characters.* Colours, deep hyacinth, or brownish red; occurs in dodecahedral crystals and massive; fracture imperfectly conchoidal; lustre vitreous.

*Chemical characters.* Fusible alone; with borax and nitre, gives a violet globule.

*Composition.* Silice 35; alumine 14; oxide of manganese 35; oxide of iron 14.—*Klaproth.*

It is singular that a substance differing so much in composition, from common garnet, should take its form and colour.

*Locality.* Franconia.

U. S. Nine miles from Philadelphia, Penn. in masses from 1 pound to 100 pounds.—*Jessup.* Corlear's Hook, N. Y. Jones' Eddy, near Bath, Maine.

*Variety 7. MELANITE.*

*External characters.* Colours, black or greyish black; occurs in rhombic dodecahedrons; often with truncated edges; fracture imperfectly conchoidal; lustre shining and resinous; opaque: sp. gr. 3.7.

*Chemical characters.* Fusible into a brilliant black globule.

*Composition.* Silice 35; alumine 6; lime 32; oxide of iron 25; oxide of manganese 0.4.—*Klaproth.*

*Localities.* Near Vesuvius in Italy. Bohemia, and in the iron mines of Lapmark.

U. S. Germantown, Penn. in gneiss; also at Morris' Hill, near the Philadelphia water works.

*Variety 8. COLOPHONITE.\**

*External characters.* Colours, blackish or yellowish brown; brownish black, or greenish; occurs in grains or in masses, composed of grains slightly adhering; also in rhombic dodecahedrons; opaque or slightly translucent; aspect resinous, and often beautifully iridescent: sp. gr. 4.

\* From the Greek, signifying *resin coloured*.

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How does the manganesian garnet differ from the common one?—What is colophonite, and why is it so called?

**Chemical characters.** Infusible, but turns black ; with borax gives a green glass.

**Composition.** Silica 38 ; lime 29 ; alumina 6 ; protoxide of iron 25.20 ; water 0.33.—*Seybert*.

This specimen was from Willsborough, N. Y.

**Localities.** Arundel in Norway, in a bed of magnetic iron ; also in Ceylon and Italy.

U. S. Willsborough, N. Y. It forms a vein 5 feet wide, in a hornblende rock, and is so plentiful that by blasting, hundreds of tons may be obtained. It is easily distinguishable from all other minerals, by the variety and brilliancy of its colours, and by its peculiar resinous aspect. It is composed of small distinct concretions, which may often be separated, even by shaking it in the hand.—*Hall*.

*Variety 9. TOPAZOLITE.\**

**External characters.** Colours, topaz yellow, or greenish ; occurs in dodecahedrons ; transparent or translucent.

**Composition.** Silica 37 ; alumina 2 ; lime 29 ; glucina 4 ; iron 25 ; manganese 2.—*Bonvoisin*.

**Locality.** Mussa, in Piedmont.

*Species 17. CINNAMON STONE.†*

**External characters.** Colours, red, brownish red, yellowish brown, and orange ; occurs in fissile masses, and in splintery fragments ; transparent or translucent ; fracture imperfectly conchoidal ; lustre shining, resinous ; sometimes occurs in dodecahedral crystals ; scratches quartz slightly : sp. gr. 3.6.

**Chemical characters.** Fusible, with ebullition, into a dark green translucent glass.

**Composition.** Silica 38.8 ; alumina 21.2 ; lime 31.25 ; oxide of iron 6.6.—*Klaproth*.

**Distinctive characters.** The fusible varieties of garnet melt into dark opaque globules, and are generally crystallized. The present species is translucent when melted and is rarely found in crystals.

**Localities.** Ceylon, in the sands, and in Brazil.

U. S. Boxborough, Mass.—*Nuttall*.

*Variety 1. ROMANZOVITE.*

**External characters.** Colours, brown, brownish black, or

\* From its being similar in colour to topaz.

† From its colour being that of cinnamon.

---

What is topazolite ?—Whence comes the name cinnamon stone ?—  
What is the composition of cinnamon stone ?

black ; occurs compact or in crystalline plates, which indicate the dodecahedron ; fracture conchoidal ; lustre oily ; scratches glass ; brittle ; streak yellow : sp. gr. 3.60.

*Chemical characters.* Fusible into a dark globule.

*Composition.* Silix 41.2 ; alumine 24.1 ; lime 24.8 ; oxide of iron 7.02 ; magnesia and oxide of manganese 0.92 ; loss 1.98.—*Nordenskiöld.*

*Localities.* Kimito, in Finland, in limestone.

*Species 18. IDOCRASE.\* VESUVIAN.†*

*External characters.* Colours, yellowish or brownish green, reddish yellow, or blackish brown ; occurs massive, but more commonly in crystals ; form, the four-sided prism, terminated by four-sided pyramids, or it sometimes assumes an eight-sided prism, by truncation of the lateral edges of the four-sided prism ; the angles of the summits being also truncated ; cleavage parallel to all the planes of the prism ; cross fracture small conchoidal ; scratches felspar ; transparent or translucent : sp. gr. 3.

Fig. 99.

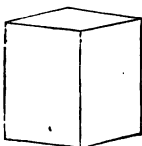


Fig. 100.

Fig. 99. A right four-sided prism, with a square base. This is the primitive form.

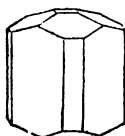


Fig. 100. The four-sided prism with the lateral edges truncated, forming an eight-sided prism, with unequal sides. The edges of the summits are also truncated.

*Chemical characters.* Fusible with ebullition into a translucent glass.

*Composition.* (That of Vesuvius) Silix 35.50 ; alumine 33 ; lime 22.25 ; oxides of iron 7.50.—*Klaproth.*

*Distinctive characters.* Pargasite, which it resembles, has

\* Idocrase, a mixed figure, in allusion to its form.

† Vesuvian, because it was found at Vesuvius.

---

Does idocrase occur in crystals, or in masses ?—What are the forms of its crystals.

not its translucency, and fuses into a white enamel. Grossular, the variety of garnet which it most resembles in colour, occurs in dodecahedrons. Olivine and chrysolite are infusible. Epidote, which resembles it in crystalline form and colour, wants its transparency, and is only fusible in part.

It is found both in volcanic, and in primitive rocks.

*Localities.* Vesuvius and Etna, Siberia, Piedmont, St. Gothard, Norway.

U. S. Worcester, Mass. in four-sided prisms, of a brown colour.—*Meade.* Salisbury, Conn.—*Silliman.* Cumberland, R. I.—*Robinson.*

*Uses.* At Naples it is cut into ring stones, and sold under various names, as chrysolite, hyacinth, &c.—*Jameson.*

*Variety 1.* EGERAN.

*External characters.* Colour, deep brown; occurs in crystals in the form of right four-sided prisms, with the lateral edges sometimes truncated; crystals deeply striated; translucent; lustre shining vitreous. It also occurs massive, composed of prismatic concretions; scratches felspar: sp. gr. 3.29.

*Chemical characters.* Fusible, into a blebby glass.

*Composition.* Silica 41; alumina 22; lime 22; iron 6; manganese 2; potash 1.—*Borkowski.*

*Locality.* Eger, in Bohemia, hence the name.

*Species 19.* GEHLENITE.\*

*External characters.* Colour, grey, with a greenish or yellowish tinge; occurs in rectangular crystals, nearly in form of a cube, also tabular; surfaces rough and dull; nearly opaque; fracture uneven, splintery; scratches glass; structure imperfectly foliated; crystals commonly aggregated: sp. gr. 3.

*Chemical characters.* Suffers no change without a flux. With borax, melts into a brownish glass.

*Composition.* Silica 29.5; alumina 14.5; lime 27.55; oxide of iron 12.2; water 6; magnesia 0.25; potash and loss 10.—*Fuchs.*

*Locality.* Fassa in the Tyrol.

*Species 20.* PREHNITE.†

*External characters.* Colours, pale green, or greenish

\* After the chemist, Gehlen.

† In honour of Col. Prehn, its discoverer.

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What is the use of idocrase?—What is the appearance of gehlenite, and whence comes its name?



white; occurs in crystalline masses of a fibrous radiating structure; also in distinct crystals, with four, six, or eight sides, and of a tabular form; translucent; in thin pieces transparent; fracture splintery; lustre shining; scratches glass: sp. gr. from 2.6. to 3.1.

*Chemical characters.* Fusible with intumescence, into a pale porous glass. Electric by heat.

*Composition.* Silica 48.8; alumina 30.33; lime 18.33; oxide of iron 5.66; water 1.88.—*Klaproth.*

*Distinctive characters.* Beryl, which it resembles in colour, is much harder and infusible; stilbite never has the green tinge of prehnite. Zeolite forms a jelly with acids, and from felspar it differs entirely, in structure.

Prehnite, though always the result of crystallization, often appears massive in consequence of the close and confused aggregation of its crystals. It generally consists, on one side, of tuberoso, warty excrescences, composed of minute crystals, with shining faces, or of granular concretions composed of radiating fibrous crystals, joined together. The other side of the mass or crust, is generally corroded and black.

*Variety 1.* KAUPHOLITE.\*

*External characters.* Colour, white or yellowish white; occurs crystallized in small rhombic tables; transparent; lustre glistening and pearly.

Fig. 101.



Fig. 101. A rhomboidal plate, the common form.

*Composition.* Silica 48; alumina 24; lime 23; oxide of iron 4.—*Vauquelin.*

Prehnite is found chiefly in secondary rock, as amygdaloid, greenstone, hornblende, rock, &c.

*Localities.* Cape of Good Hope, where it was first discovered by Col. Prehn; Tuscany, Tyrol, many places in Scotland, and in England.

U. S. Scotch Plains, Patterson, and near Newark, N. J. At the latter place, masses are found near a foot in diameter.—*Torrey.* Staten Island, N. Y. New-Haven, Berlin, Wood-

\* From the Greek, signifying a light stone.

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What is the colour and appearance of prehnite?

bury, Simsbury, Granby, Farmington, Hartford, and Windsor, Conn. Brookfield, Watertown, and Charlestown, Mass. At the latter place, in hexagonal tables.—*Waterhouse*. Bellows Falls, Ver.

*Species 21. STILBITE.\**

**External characters.** Colours, white, grey, yellowish, brownish, orange red, and brick red; occurs crystallized in the form of four-sided prisms, which is the primitive form; also variously modified by truncation. Sometimes it is compressed into the form of a table, and sometimes it assumes the form of a six-sided prism. It terminates in four-sided pyramids, often with truncated angles; translucent, or transparent; structure foliated in one direction; yields to the knife; lustre pearly; crystals sometimes slender and fasciculated: sp. gr. 2.5.

Fig. 102.

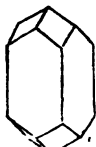


Fig. 102. A four-sided prism, terminated by four-sided pyramids, the faces of which, are set on the angles of the prism. This is a common form.

**Chemical characters.** Fusible into a blebby, colourless glass.

**Composition.** Silica 50.24; alumina 29.3; lime 9.46; water 10.—*Vauquelin*.

**Distinctive characters.** Zeolite, which it resembles, forms a jelly with acids, and becomes electric by heat. Prehnite is harder than stilbite, and has not its pearly lustre. Stilbite is foliated, which is not the case with prehnite.

Stilbite is found in the fissures of primitive rocks. It is also associated with zeolite, chabasite, and carbonate of lime, in secondary rocks.

**Localities.** Dauphiny, of a pale straw colour. Arendal, in Norway. Iceland. Scotland. Giant's Causeway, and in the Faroe Islands.

U. S. Woodbury, Conn. Deerfield, Mass. associated with chabasite.—*Hitchcock*. Scotch Plains, N. J. in four-sided prisms, and six-sided tables.—*Pierce. Torrey*. West Farms, N. Y. pale and deep red.

\* A peculiar lustre.

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What are the colours and crystalline forms of stilbite.



*Species 22. HEULANDITE. FOLIATED ZEOLITE.*

*External characters.* Colours, white, yellowish white, brownish, red, and sometimes colourless; occurs crystallized in the form of a right oblique angled prism, (two of its opposed lateral planes being longer than the other two,) generally modified by truncation; faces bright and shining; lustre pearly; translucent or transparent; brittle.

*Chemical characters.* Fusible, with phosphorescence into a porous glass.

*Composition.* Silica 52.6; alumina 17.5; lime 9; water 18.5.—*Vauquelin.*

*Distinctive characters.* It does not form a jelly with acids, like zeolite. Its crystalline form differs from that of stilbite.

*Localities.* Faroe Isles, Giant's Causeway; Tyrol and Norway.

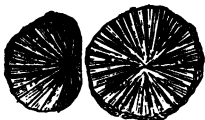
This mineral was considered as a variety of zeolite, by Werner and Jameson, and a variety of stilbite, by Haüy.

U. S. Chesterfield, Mass. associated with stilbite and chabasite. Distinguished by its superior pearly lustre. Chester, Mass.

*Species 23. ZEOLITE. MEZOTYPE.*

*External characters.* Colours, white, sometimes shaded with yellow, grey, or red; occurs in masses and in crystals; form the four-sided prism terminated by four-sided pyramids; but more commonly it is found in masses composed of radiating fibres, or in fasciculated minute crystals of a stellate aspect. Sometimes the crystals are so broad as to give a foliated appearance; fracture splintery; lustre pearly or silky; translucent, sometimes nearly transparent; scratches carbonate of lime: sp. gr. 2.

*Fig. 103.*



*Fig. 103. Radiated zeolite.*

*Chemical characters* Fusible, with intumescence, and phosphorescence into a spongy enamel. Phillips says, fusible without intumescence. It forms a jelly with nitric acid. The proportion of acid should be small.

*Composition.* Silica 54.24; alumina 29.3; lime 9.46;

What are the colours of Heulandite?—What are the colours of zeolite?—What are the chemical characters of zeolite.

water 10.—*Vauquelin*. Tennant found 17, and Gehlen 15 per cent. of soda. Possibly these gentlemen analyzed different minerals.

**Distinctive characters.** In its radiated structure, zeolite closely resembles prehnite, but differs from it in colour, hardness, and lustre. Stilbite is foliated. Chabasie is crystallized in cubes, and from all these as well as from analcime, harmotome, and heulandite, it may be known by its forming a jelly with nitric acid.

Zeolite is often found in thin fibrous coats investing other minerals.

*Variety 1. MESOLITE. NEEDLESTONE.*

**External characters.** Colours, white, or greyish white, or colourless; occurs in long slender prisms, terminated by four-sided pyramids; crystals often radiate from a centre; lustre pearly; resembles zeolite, except in the distinctness and length of the crystals.

**Chemical characters.** Becomes opaque, curls, and then melts into a porous bead.

**Composition.** Silex 45.8; alumine 26.50; lime 9.87; soda 5.40; water 12.30.—*Berzelius*.

**Localities.** Pargas, in Finland. Iceland, Faroe Islands, and in the Tyrol.

*Variety 2. NATROLITE.*

**External characters.** Colours, white, yellowish white, or reddish brown, disposed in alternate zones around the centre; occurs in mammillary masses composed of diverging fibres; lustre pearly or dull: sp. gr. 2.2

**Chemical character.** Before the blow-pipe, behaves like zeolite.

**Composition.** Silex 48; alumine 24.25; soda 16.5; water 9; oxide of iron 1.75.—*Klaproth*.

**Localities.** Near the lake of Constance. In Scotland, and in Suabia.

*Variety 3. MEALY ZEOLITE.*

**External characters.** Colours, white, yellowish grey, or reddish; occurs in dull friable masses, or in thin coats on other minerals; fracture earthy.

It is, probably, zeolite in a decomposing state.

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**How is this mineral distinguished from others? What are the varieties of zeolite?**

*Variety 4. THOMSONITE.\**

*External Characters.*—Colours, white and translucent ; in thin pieces transparent ; occurs in radiating fibrous masses, in the cavities of which are sometimes formed crystals, in form of a right prism, with square bases.

*Chemical characters.* Infusible, but swells, curls, and becomes snow white, and opaque, and loses 13 per cent. of its weight.

*Composition.* Silex 36.8 ; alumine 31.36 ; lime 15.4 ; magnesia 0.2 ; peroxide of iron 0.6 ; water 13.—*Thomson.*

Phillips has made a species of Thomsonite, but it is evidently a variety of zeolite.

Zeolite is found in secondary rocks, as basalt, greenstone, porphyry, and amygdaloid. It occurs in small masses, or investing these minerals in thin coats. Sometimes it runs in veins, but is seldom more than half an inch, or an inch thick. It is associated with prehnite, stilbite, analcime, calcareous spar, &c.

*Localities.* Scotland, England, Faroe Islands, Brittany, Tyrol, &c.

U. S. Near New Haven, Con. in secondary greenstone.—*Silliman.* Patterson and Scotch Plains, N J. in four-sided prisms. Deerfield, Mass. in radiated masses.—*Hitchcock.* At Jones's Falls, Md. Near Philadelphia. Near Baltimore, Md. in quadrangular prisms.—*Gilmor.*

*Species 24. WERNERITE.*

*External characters.* Colours, greenish grey, olive green, bluish green, and greyish white ; occurs massive and crystallized in eight-sided prisms, terminated by four-sided pyramids ; lustre glistening or shining ; structure foliated ; translucent or transparent ; crystals often long and deeply striated ; the massive is composed of parallel or diverging crystals ; fracture splintery ; fragments angular ; scratches glass : sp. gr. 2.25.

*Chemical characters.* Fusible, with intumescence, into a white, shining enamel.

*Composition.* Silex 40 ; alumine 34 ; lime 16 ; oxide of iron 8 ; oxide of manganese 1.5.—*John.*

*Localities.* Buoen, in Norway. Ulrica, in Sweden.

\* In honour of Dr. Thomson.

*Variety 1. SCAPOLITE.*

*External characters.* Colours grey, white, greenish white, yellowish, and greenish grey; occurs massive and crystallized in four or eight-sided prisms, terminated by four-sided pyramids; primitive form, a right four-sided prism; cleavage parallel to the sides, terminal planes, and both diagonals of a square prism; crystals long and often striated; sometimes acicular and radiating, but more often broad, and collected into groups or masses; structure foliated; translucent; lustre pearly; scratches glass: sp. gr. 2.5.

*Chemical characters.* Fusible, with intumescence into a shining white enamel. Liable to decomposition, by which it becomes dull, and efflorescent.

*Composition.* Silica 45; alumina 33; lime 17.6; potash 0.5; soda 1.5; oxide of iron and manganese 1.—*Laugier.*

*Distinctive characters.* It is harder, and less easily fusible than zeolite, or stilbite, nor is it like these soluble in acids. Its crystalline form and structure will distinguish it from prehnite and analcime. Apophyllite separates into flakes in acid, which scapolite does not.

*Localities.* Arendal, in Norway, with oxide of iron. In various places in Sweden and Greenland.

U. S. Bolton, Mass. colour white, crystals two inches long, form four-sided prisms.—*Meade.* Near Baltimore, Md. At Cold Spring, and at West Point, N. York.

The external characters of Wernerite and scapolite are very nearly the same, and with the exception of a small portion of alkali in the Wernerite, there is nearly an identity of composition. Cleaveland has blended the descriptions of both under scapolite. Jameson and Phillips make them separate species. The alkali has not been thought a sufficient reason for separating them, and scapolite has therefore been placed as a variety of Wernerite, until further analysis shall determine its place.

*Species 25. ZOISITE.*

*External characters.* Colours, grey or greyish yellow, or brown; occurs in rhombic prisms, which are compressed and deeply striated longitudinally; terminations commonly incomplete. It also occurs massive; cleavage parallel to the sides

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What are the colours and chemical characters of scapolite? How is this mineral distinguished? What is zoisite?

of a right rhombic prism ; translucent ; lustre pearly ; scratches glass.

**Chemical characters.** Fusible at first into a yellowish transparent glass, but finally into a vitreous scoria ; with borax swells, and melts into a vitreous scoria.

**Composition.** Silica 45 ; alumina 29 ; lime 21 ; oxide of iron 2.4.—*Klaproth*.

**Distinctive characters.** It resembles epidote and tremolite ; but the first gives a colored glass with borax, and the second melts into a white enamel.

**Localities.** Carinthia, Franconia, Bavaria, and Tyrol.

U. S. East Marlborough, in regular tetrahedral prisms. Pittsfield, Mass. Near Philadelphia, Penn. Woodstock, Vt.

**Species 26. EPIDOTE.**

**External characters.** Colours, yellowish, bluish, or blackish green ; occurs massive, granular, and crystallized in four, six, eight, or twelve-sided prisms ; lustre of the massive, glimmering, of the crystals, shining ; translucent or opaque ; fracture of the massive, uneven and splintery ; crystals generally grouped, and the crystallization often confused ; scratches glass : sp. gr. 3.45.

Fig. 104.



Fig. 105.

Fig. 104. A four-sided prism with truncated edges, and terminated by two faces standing on the truncated angles.

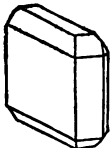


Fig. 106.

Fig. 105. A four-sided prism, also truncated, and terminated by four planes standing obliquely on the lateral planes.



Fig. 106. A six-sided prism, with unequal lateral planes, and terminated by two unequal faces.

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What are the distinctive characters of zoisite ? What are the colours of epidote ?

**Chemical characters.** Turns black, the sharp angles only being fusible into a shining glass. With borax slowly fusible into a greenish transparent glass.

**Composition.** Silica 37; alumina 21; lime 15; oxide of iron 24; oxide of manganese 15.—*Vauquelin*.

**Distinctive characters.** It resembles actinolite, but the latter turns greyish white, under the blowpipe. This difference will always distinguish these two minerals, provided crystalline fragments of each be taken. Hornblende is easily fusible into a black shining globule. Idocrase is fusible into a translucent yellowish glass. Sahlite whitens and becomes glazed with a yellowish glass. These differences will distinguish the present species.

#### Variety 1. MANGANESEAN EPIDOTE.

**External characters.** Colours, reddish brown, or violet; occurs in small prismatic crystals, closely aggregated into groups; opaque; yields to the knife.

**Chemical characters.** Fusible with ease into a black glass: with borax into a transparent glass.

**Composition.** It contains about 12 per cent. of oxide of manganese.

**Localities.** Piedmont, in gneiss, with quartz and asbestos.

#### Variety 2. GRANULAR EPIDOTE. SKORZA.

**External characters.** Colour, yellowish green; occurs in grains of various sizes, and appears to be common epidote disintegrated and reduced to grains by attrition.

**Composition.** Silica 43.0; alumina 21; lime 14; oxide 16.5; oxide of manganese 0.25.

**Localities.** The borders of the river Aransas, in Transylvania.

Epidote is found chiefly in primitive rocks, both disseminated and in veins.

**Localities.** Isere, in France. Chamouni, in the Alps. Arendal, in Norway, crystals an inch in diameter. England, Scotland, Ireland, &c.

U. S. Middlebury and Chester, Vt. Near Lake George, N. Y. Cumberland, R. I. Near Baltimore, Md. Blue Ridge, Va. Milford, Con. Litchfield and Washington, Con.; also at Haddam, Saybrook, and Tolland, Con. Near Boston, Brighton, Dedham, &c. Mass. Also at Newbury, in large

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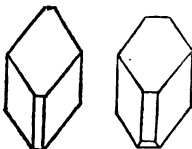
What are the chemical and distinctive characters of epidote?—What are the varieties of epidote?—Is epidote a rare, or a common mineral?

crystals.—*Webster*. Franconia, N. H. Near New York; also in West Chester, and in the Highlands, N. Y.

*Species 27. AXINITE.*

**External characters.** Colours, violet, brown, green, grey, yellow, and white; occurs in crystals, the form of which is an oblique rhomb, or four-sided prism, so compressed that the edges appear sharp like the edge of an axe; angles often truncated; lustre splendid; fracture uneven; fragments angular; translucent or transparent; occurs also massive; scratches glass: sp. gr. 3.2 to 3.30.

Fig. 107. Fig. 108.



Figs. 107 and 108, present the common forms of these crystals.

**Chemical characters.** Fusible into a dark greenish glass.

**Composition.** Silica 44; alumina 18; lime 19; oxide of iron 14; oxide of manganese 4.—*Vauquelin*.

The crystals are generally striated, except the greenish variety, which is the most perfect.

The same crystal is sometimes of various colours, and has various degrees of transparency.

Some crystals, and particularly the violet coloured, become electric by heat.

It is found in primitive rocks and is rather a rare mineral.

**Localities.** Thum\* in Saxony. In the Pyrennees. Mount Atlas. Arendal, in Norway. France. Cornwall, Eng.

*Species 29. LAPIS LAZULI.*

**External characters.** Colour, azure blue of various tints, but always intense and beautiful; occurs massive; structure fine grained and compact; lustre glimmering; fracture uneven; scratches glass; opaque or translucent on the edges: sp. gr. 2.9.

**Chemical characters.** Fusible with difficulty into a glassy globule, at first bluish, but soon becomes white. With borax forms a clear glass.

**Composition.** Silica 49; magnesia 2; alumina 11; lime

\* Jameson calls it *thumerstone* on this account.

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What are the colours of axinite?—What is the colour of lapis lazuli?  
—What is the composition of this mineral?

16; potash and soda 8; oxide of iron 4; sulphuric acid 2.—*Gmelin.*

Klaproth found neither soda nor potash. Clement found soda 23.2, and sulphur 3.1.

*Distinctive characters.* Its peculiar and beautiful colour, will distinguish it from most other minerals. The blue carbonate of copper, which its colour most resembles, becomes dark, and is reduced by the blow pipe.

The colour of Lapis Lazuli is seldom uniform, and the stone is often interspersed with spots, or veins of iron pyrites.

*Localities.* China, Persia and Bucharia.

According to Patrin, as quoted by Pinkerton, it chiefly comes from Great Bucharia, where it exists in rocks of granite. The amount of Patrin's information on this subject is as follows.

Lapis is seldom found pure, except in small pieces.

It is disseminated through a granite rock, in all sorts of proportion, but it is rare to find a piece as big as one's head, in which the blue predominates over the white and grey.

It is sometimes found in solid pieces, and particularly on the Lake Baikal.

*Uses.* Lapis Lazuli receives a high polish and is in great demand as an ornamental stone. Specimens in which the yellow pyrites is intermixed, are often extremely beautiful. In the palace which Catharine II. built for her favorite Orlof, at St. Petersburg, Patrin says, there are some apartments entirely lined with lapis, and that it would be scarcely possible to imagine a decoration more simple, and at the same time more magnificent.

But the most important use of this mineral, is that of furnishing the celebrated and beautiful pigment called *ultra-marine blue*.

Beckmann, in his history of inventions, has devoted an entire chapter to this subject, and as usual, has quoted a great number of authors. From him we learn as follows.

Lapis Lazuli was well known to the ancients, under the name of *sapphire*.

The process of preparing the ultra-marine, was known as early as the 15th century.

In the eleventh century, lapis, or some preparation of it, was used in medicine.

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What is the use of this mineral?—Where is it found?—Was it known to the ancients?



It appears also that the process for making ultra-marine, was for a long time kept a secret, and the paint sold at a great price. In 1763, an ounce of it cost at Paris, four pounds sterling. It was also sold at a ducat per ounce at Hamburgh, and was warranted to "stand proof by fire."

The walls of the palace at St. Petersburg mentioned above, Beckmann says, are covered with amber, interspersed with plates of this costly stone.

The process of extracting the ultra-marine, is found in books on chemistry. It is employed in oil, and not only gives the richest and most beautiful of all blue colours, but is said never to fade; hence its high price.

Some engravings have been executed on this stone, but it is much too soft for this purpose.

*Species 30. DIPYRE.*

*External characters.* Colours, greyish or reddish white; occurs in slender prisms, fasciculated into masses; form six-sided prisms, but often so minute as to render it difficult to ascertain their modifications; scratches glass: sp. gr. 2.63.

*Chemical characters.* Turns milk white, phosphoresces, and melts into a blebby colourless glass.\*

*Composition.* Silex 60; alumine 24; lime 10; water 2.—*Vauquelin.*

*Localities.* Pyrennees, in steatite, mingled with sulphuret of iron. It is very rare.

*Species 31. LAUMONITE.†*

*External characters.* Colours, white, sometimes with a tinge of yellow, or red; occurs in aggregated crystalline masses, and in regular crystals; form an octahedral prism, with dihedral summits, variously modified by truncation; primary form, an oblique rhombic prism; fracture foliated; structure lamellar; cleavage perfect in two directions; translucent, or transparent; scratches glass: sp. gr. 2.2.

Fig. 109.

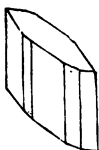


Fig. 109. A four-sided prism with rhombic terminations, and truncated lateral edges.

\* Hence the name, which in Greek signifies the double effects of fire, in allusion to its turning white and phosphorescing.

† In honor of Gilbert Laumont.

What is the appearance, and whence the name of Dipyre?—What is the colour of laumonite, and what are its peculiarities?

Fig. 110.



Fig. 110. A short four-sided prism, truncated on the solid angles. These are two of the most common forms.

*Chemical characters.* Fusible with difficulty, into a porous colourless glass. Forms a jelly with acids.

*Composition.* Silica 49; alumina 22; lime 9; water 17.5; carbonic acid 2.5.—*Vogel*.

The above description applies to the present species, only in its recent, or perfect state. On exposure to the air it *effloresces*, or loses its water of crystallization, and divides into angular fragments; becomes opaque, of a milk white colour, and pearly lustre, and finally falls into powder. Its appearance in this state, is much like that of selenite, after being exposed to heat.

*Localities.* Brittany, in a lead mine. Ireland, and Faroe, in trap. China, Transylvania, St. Gothard. England, in several places.

U. S. Near New-Haven, Conn.—*Silliman*. Phillipstown, N. Y.—*Barratt*.

#### *Species 32. CLAY SLATE.*

*External characters.* Colours, reddish, bluish, or greenish, brown, also yellowish brown and black, always dull; occurs massive; structure slaty; lustre glimmering; principal fracture slaty; cross fracture earthy, or uneven; opaque; yields to the knife; does not adhere to the tongue: sp. gr. about 2.5.

*Chemical characters.* Fusible into a black slag.

*Composition.* Silica 48; alumina 25.5; magnesia 1.6; oxide of iron 11.3; oxide of manganese 0.5; potash 4.7; carbon 0.3; water 7.6.—*Kirwan*.

It is very universally distributed, and forms vast strata in different countries.

*Localities.* England. Scotland. Ireland, &c.

U. S. Hartford, Windsor, Suffield, Conn.

#### *Variety 1. ROOF SLATE.*

*External characters.* Colours, brownish black or bluish black; occurs massive in beds; fracture splintery; cleavage perfect in one direction; easily fusible; surface smooth, or

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What is the composition of clay slate.

slightly undulating; divides into large thin plates; sonorous, when suspended and struck with a hard body.

It is found both in primitive and secondary rocks.

*Localities.* It is found in most European countries.

U. S. Wayne, York, and Lancaster counties, Penn. (quarried). Hoosack, N. Y. (quarried). Dummerston, Rockingham, Castleton, and Brattleborough, Ver. Charlestown, Mass. extensively quarried.

*Uses.* It is employed extensively in cities, to cover the roofs of buildings. Also, to write upon in schools, &c.

In Pennsylvania, roof slate is quarried, to the amount of about 1600 tons annually. It sells at Baltimore, for \$22, the ton.—*Hayden.* It is also extensively quarried at Dummerston, and Brattleborough, Ver.—*Hall.* And at Charlestown, Mass.—*Dana.*

#### *Variety 2.* SHINING ARGILLITE.

*External characters.* Colours, blue, bluish black, grey, and reddish; occurs massive; fracture slaty; surface undulating or waved; lustre shining, sometimes pseudo-metallic.

This variety is primitive, and passes into mica slate. It abounds with ores; most of the tin and copper mines of Cornwall, traverse this rock.

#### *Variety 3.* SHALE.

*External characters.* Colours, grey, bluish black, brown, reddish, or greenish; occurs massive; fracture uneven; lustre dull; more or less fusible; yields to the knife; layers often uneven, protuberant, or knobby; adheres a little to the tongue.

*Chemical characters.* It is fusible by the blow pipe.

This variety often disintegrates, and falls in pieces.

*Distinctive characters.* It is less solid, and not so hard as argillite; and does not, like roof slate, split into thin smooth layers.

#### *Variety 4.* BITUMINOUS SHALE.

*External characters.* Colour, black or brown; structure slaty; fracture conchoidal; lustre a little shining or dull; yields easily to the knife: sp. gr. about 2.

This variety contains a considerable quantity of bitumen. When heated or struck, it exhales a strong bituminous odour, and often burns with a flame. It is a strong indication of coal.

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What is the colour and what are the uses of roof slate?—What is shining argillite?—How does bituminous shale differ from clay slate?

Shale frequently exhibits impressions of vegetables, as reeds, ferns, leaves, &c. It also exhibits impressions of fish.

*Localities.* England, Scotland, &c.

U. S. Virginia, Rhode Island, Ohio, Connecticut, &c.

It is found with the Rhode Island anthracite, containing impressions of vegetables.

At Westfield, Conn. is a bed of highly bituminous shale, containing numerous impressions of fish. Sometimes the fish are a foot, or two feet long, the head, fins, and scales, being perfectly distinguishable. A single specimen sometimes presents parts of three or four fish, lying in different directions, and between different layers. They are sometimes contorted and almost double. Their colour, sometimes grey, is usually black, and the fins and scales, appear to be converted into coal.—*Silliman*.

*Variety 5.* NOVACULITE. WHET SLATE.

*External characters.* Colours, yellowish white, or blackish grey, often running in stripes; translucent on the edges; texture fine grained or compact; structure slaty, more or less fissile; fracture conchoidal; fragments sharp edged: sp. gr. 2.75.

*Chemical character.* Fusible into a brownish, porous enamel.

*Composition.* Silica 71.3; alumina 15.3; oxide of iron 9.3; water 3.3.—*Faraday*.

The Turkish hone often presents the two colours, pale yellow, and bluish or greenish grey, in distinct layers, or stripes. It is from this circumstance, perhaps, that this substance is thought by many to be petrified wood. Sometimes the two layers are cemented together. The yellow, is generally more compact and hard, than the bluish.

*Localities.* In the primitive mountains of Saxony, and in several parts of Germany. It was first brought from the Levant, hence it was called *Turkish hone*.

U. S. Berks county, Penn. It is explored, and sells at 25 cents the pound.—*Cooper*. Arkansas Territory, of a good quality.—*Schoolcraft*. Charlestown, Malden, and Dorchester, Mass.—*Dana*. Thetford, Ver.—*Hall*. Kennebec river, Maine.—*Cleaveland*.

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What is said of impressions of fish and vegetables on bituminous shale?—Is the Turkish hone a petrification or not?—Is novaculite found in this country?

**Uses.** It is employed to give a fine edge to cutting instruments.

**Variety 6. ALUM SLATE.**

**External characters.** Colours, bluish or greenish black, or iron black; sometimes iridescent; structure slaty; layers often curved or undulated; lustre glimmering or dull; fracture uneven or earthy: sp. gr. 2.33.

**Chemical characters.** Fusible. It turns red by the action of heat, and falls in pieces.

**Composition.** Silex 40; alumine 16; carbon 19.6; sulphur 2.8; sulphate of iron, lime, and potash 1.5 each; iron 6.4; water 10.7.—*Klaproth*.

On exposure to the air, it disintegrates, and throws out a saline efflorescence, which covers the surface with a white powder, and which is found to be alum. The production of this salt is explained on the principle of chemical affinity. The sulphur, on exposure, absorbs oxygen from the atmosphere, and is converted into sulphuric acid, which then unites to the alumine and potash, and forms a *sulphate of alumine and potash*, or alum. The alum is then obtained by lixiviation.

**Localities.** Yorkshire, and near Whitby, Eng. At Whitby are extensive alum works. Also in Italy, near Rome.

U. S. Frederic and Washington Counties, Md. Near Zanesville, Ohio. Near New Lebanon Springs, N. Y. Pownal, Vt. Also in the western counties of Pennsylvania.

**Variety 7. ADHESIVE SLATE.\***

**External characters.** Colours, yellowish grey, or greenish brown; occurs massive; texture slaty, which becomes visible on exposure; but if the mass be moistened, the slaty characters disappear; splits easily; yields to the knife; adheres to the tongue: sp. gr. about 2.

**Composition.** Silex 82.50; alumine 0.75; lime 0.25; magnesia 8.0; carbon 0.75; iron 4.—*Klaproth*.

**Locality.** Near Paris, in the gypsum formations.

**Variety 8. POLISHING SLATE.**

**External characters.** Colours, white, yellowish white, or yellow; occurs massive; structure slaty; opaque; brittle; often swims on water for a short time.

**Composition.** Silex 83.50; alumine 4; lime 8.50; oxide of iron 1.60; water 9.0.—*Bucholz*.

\* Because it adheres to the tongue.

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What is alum slate, and how is alum obtained from it?

*Localities.* Bohemia, Saxony, and Auvergne. It is supposed to be a volcanic production.

*Uses.* It is used for polishing glass, marble, the metals, &c.

**Variety 9. GRAPHIC SLATE. BLACK CHALK.**

*External characters.* Colours, black, greyish, or bluish black; structure slaty; fracture earthy; leaves a black dull trace on wood, or paper; opaque; soils the fingers: sp. gr. 2.14.

*Composition.* Silice 64; alumine 11.25; carbon 11; oxide of iron 2.75; water 7.5.—*Weiglib.*

It is found with argillite, and in the vicinity of coal formations.

*Localities.* Spain, France, Italy, Iceland, &c.

U. S. Rhode Island, with anthracite. On the Susquehanna, Penn.

*Uses.* It is employed for tracing lines on wood, and for making crayons, for drawings.

**Species 33. SILICIOUS SLATE.**

*External characters.* Colours, grey, bluish grey, reddish, brown or black; occurs massive; structure slaty; fracture imperfectly conchoidal; lustre glimmering; hardness about equal to that of quartz; translucent on the edges; colours sometimes arranged in spots or stripes: sp. gr. 2.59 to 2.64.

*Chemical characters.* Infusible, but turns reddish.

*Composition.* Silice 75; the remainder being lime, magnesia, and oxide of iron.—*Weiglib.*

*Localities.* Saxony, Bohemia, France, Scotland.

**Variety 1. BASINITE. TOUCHSTONE.**

*External characters.* Colours, greyish black, or black; occurs massive, and in rolled pieces; opaque; fracture conchoidal; streak black.

This variety was formerly much employed as a test of the purity of gold. The metal being drawn across the stone, a judgment of its purity or quantity of alloy, is formed by the colour of the streak; and if this is not satisfactory, the trace of metal is touched with nitric acid, which dissolves the alloying substance without touching the gold. Hence the name *touchstone*.

*Localities.* U. S. Topsham, Mass. Northampton, N. H. Near Reading and Bethlehem, Penn. Topsham, Me.

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What is the use of graphic slate? What is the composition of silicious slate? What is the use of the touchstone?

*Species 34. CLAY.*

The varieties of this species are composed of siliceous and aluminous, with variable proportions of oxide of iron, and sometimes a little carbon, manganese and water.

*Variety 1. INDURATED CLAY.*

*External characters.* Colours, grey, yellowish grey, brown, reddish, and sometimes greenish; occurs massive; fracture conchoidal and splintery; yields to the knife; texture compact, or porous; yields an argillaceous odour when moistened; crumbles and falls in pieces in water; opaque; specific gravity about 2.21.

It sometimes forms the basis of porphyry.

*Chemical characters.* Infusible, but becomes glazed by heat.

It often occurs in extensive beds.

*Variety 2. IRON CLAY.*

*External characters.* Colour reddish, or yellowish brown, occurs massive; fracture earthy; opaque; easily broken; gives an argillaceous odour; often porous, or amygdaloidal.

*Localities.* Ireland, Scotland, England, &c.

*Variety 3. WACKE.\**

*External characters.* Colours, yellowish grey, brownish, greenish, or reddish; occurs massive; fracture conchoidal, or earthy; opaque; unctuous to the touch; gives the argillaceous odour when breathed on; may be cut by a knife: sp-gr. 2.53, to 2.89.

*Chemical character.* Fusible into a porous slag.

*Composition.* Siliceous 28; aluminous 23; lime 4.5; water 16.18; oxide of iron 26; carbonic acid 2.32.—*Webster.*

It is associated with basalt, and seems to be intermediate between that substance and clay.

*Localities.* Germany, Scotland, Saxony, Norway.

U. S. Near Boston, Mass. It there forms the basis of amygdaloid.—*Cleveland.*

It frequently contains embedded crystals, of mica, hornblende, calcareous spar, &c. In it are also found magnetic iron, chalcedony, agate, and zeolite. It also sometimes contains fossil bones, and petrified wood, but *Jameson* says, it never, like basalt, contains augite, or olivine.

\* Pronounced *Wak-ke.*

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What are the varieties of clay composed of?—What kind of a stone is wacke?

**Variety 4. ROTTEN STONE.**

*External characters.* Colour, brownish grey, or reddish brown, passing into black; occurs massive; fracture earthy and dull; soft; soils the fingers; fetid when rubbed or scraped.

*Composition.* Alumine 86; silice 4; carbon 10.—*Phillips.*

*Locality.* Derbyshire, where it is believed to arise from the decomposition of the shale, of that country.—*Phillips.*

U. S. Albany, N. Y.

**Variety 5. PORCELAIN CLAY. KAOLIN.**

*External characters.* Colour, yellowish, or reddish white; occurs massive; composed of small particles slightly coherent; soft; friable between the fingers; unctuous to the touch; adheres slightly to the tongue; absorbs water, and falls to powder; but does not form a ductile paste: sp. gr. 2.20 to 2.40.

*Chemical character.* Infusible.

*Composition.* (From Saxony,) Silice 55; alumine 27; lime 2; water 14; oxide of iron 5.—*Vauquelin.* (From Cornwall,) Silice 20; alumine 60; water 12.—*Wedgewood.* (From Vermont,) Silice 56; alumine 43.—*Smith.*

This is the clay of which China or porcelain ware is manufactured. It is infusible even in a porcelain furnace, when pure, but hardens, and acquires a degree of firmness, though not sufficient for the purposes of the manufacturer, without the addition of some flux, as a little lime, by which it is softened in the fire, and as it cools assumes the proper degree of hardness and firmness.

Sometimes the best porcelain clay is of a yellowish colour, probably from the intermixture of earthy matter, as it becomes white in the fire. When coloured by oxide of iron, or other metallic oxides, it becomes reddish or brown in the fire, by which its value is greatly lessened. The value of this clay, can therefore be ascertained, only by actual experiment.

Porcelain clay is found in primitive rocks, where it occurs in beds, more or less extensive. It is produced by the decomposition of felspar, one of the component parts of granite, and more particularly of graphic granite, which is almost entirely composed of felspar.

*Localities.* Meissen, in Saxony, and from which the Saxon porcelain is made. Limoges, in France. Cornwall, in England. Near Passau, in Austria, &c.

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What is the colour of porcelain clay?—Why is it called porcelain clay? Where is this clay found?



U. S. Monkton, Vt. At this place, it appears to form a large bed, and to be of a good quality for the manufacture of porcelain.—*Silliman*. Near Wilmington, Del. Near Philadelphia, Penn. in several places.—*Wister*. Washington, Conn. in small quantities.

*Variety 6. LITHOMARGE.\**

*External characters.* Colours, reddish or yellowish white, also bluish, and greyish white, often spotted internally; occurs massive; opaque; fracture conchoidal; texture fine grained; soft; adheres to the tongue; polishes with the nail; falls to powder in water, but does not form a paste: sp. gr. 2.20.

*Chemical characters.* Infusible; sometimes phosphoresces, when heated.

*Composition.* Silica 45.2; alumina 39.5; water 14; oxide of iron 2.7.—*Klaproth*.

It is found in veins in porphyry, gneiss, and serpentine, and in beds over coal.

Werner divides it into two kinds, *indurated* and *friable*.

*Localities.* Saxony, England.

U. S. Bare Hills, near Baltimore, Md. Montgomery County, Penn.

*Variety 7. FULLER'S EARTH.*

*External characters.* Colours, greenish brown, greenish grey, greenish white, yellowish, reddish, and bluish, sometimes striped or spotted; occurs massive; fracture somewhat conchoidal; texture earthy; polishes with the finger nail; unctuous to the touch; soft and tender; becomes translucent when thrown into the water, and falls into a pulpy impalpable powder; but does not become ductile: sp. gr. 1.7 to 2.

*Chemical characters.* Fusible into a porous slag. Turns white when heated.

*Composition.* Silica 53; alumina 10; water 24; magnesia 1.25; lime 0.5; muriate of soda 0.1; oxide of iron 9.75.—*Klaproth*.

It is found in beds, sometimes enclosing fossil wood, sea shells, sulphate of barytes, and quartz.

*Localities.* The best, is said to occur in England. It is also found in Austria, Saxony, &c.

U. S. Newfield, Maine. Kent, Conn.

*Uses.* This earth was formerly much employed, in the

\* Signifies, Rock Marrow.

What are the colours of fuller's earth?

filling of cloth, whence its name. At the present time, soap is generally substituted.

*Variety 8. TRIPOLI.\**

*External characters.* Colours, various shades of grey, yellow, and red; occurs massive; fracture dull, coarse, and earthy; yields to the nail; rough to the touch, opaque; aspect argillaceous; indurated or friable; does not form paste with water: sp. gr. 2.20.

*Chemical characters.* Infusible, sometimes effervesces with acids, from foreign ingredients.

*Composition.* Silica 90; the rest being alumina, oxide of iron, and lime.

It is found among secondary rocks, or in alluvial earths.

*Localities.* France, Bohemia, Saxony, Brittany, &c.

*Uses.* It is used, like emery, for polishing metals, stones, marble, &c.

*Variety 9. BOLE.*

*External characters.* Colours, reddish yellow, brownish black, yellowish white, or pitch black; occurs in solid amorphous masses; opaque; fracture conchoidal; smooth to the touch; yields an argillaceous odour when moistened; soils the fingers: sp. gr. 2.

*Chemical characters.* Turns red, or black, and melts into a porous slag.

*Composition.* (From Lemnos,) Silica 66; alumina 14.5; water 8.5; oxide of iron 6; soda 3.5; lime and magnesia 0.5.—*Klaproth.*

It is found with basalt and wacke.

*Localities.* Armenia and Lemnos.

Bole appears to be a fine clay, coloured by iron.

*Uses.* Formerly the Armenian bole was much employed in medicine as an astringent and absorbent. That of Lemnos was used when moistened, and made into a thick paste, to take the impressions of seals, and hence was called *terra sigillata*. Bole from Sienna, called *Terra de Sienna*, is a dark brown colour, and is used as a paint. At the present time, the red bole is employed at Constantinople, to form the bowls of their tobacco pipes. It takes an exact and beautiful impression

\* It was first brought from Tripoli.

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Why is this variety called by this name?—What is the composition of Tripoli, and what its uses?—What are the uses of bole?

from the mould, and when gilded, appears like the finest workmanship.

*Variety 10. CIMOLITE.*

*External characters.* Colour, internally greyish white, but acquires a reddish tint by exposure ; occurs massive ; fracture earthy ; texture a little slaty ; yields to the nail ; adheres to the tongue ; gives a shining streak ; falls to pieces in water : sp. gr. 2.

*Chemical characters.* It whitens, but is infusible.

*Composition.* Silica 63 ; alumina 23 ; water 12 ; iron 1.25.

—*Klaproth.*

*Locality.* Argenteria, formerly *Cimolus*, an island in the Archipelago, situated near Nilo.

*Uses.* It was employed by the ancients as a detergent, and is used by the inhabitants of the island as a substitute for fuller's earth, at the present day.

*Variety 11. MOUNTAIN MEAL.*

This singular substance was found in the form of a bed, by Fibbroni, at Santa Fiori, between Tuscany and the Papal dominions. It is formed into bricks, so light as to swim on water.—*Phillips.*

*Composition.* Silica 79 ; alumina 5 ; oxide of iron 3 ; water 12.—*Klaproth.*

*Variety 12. PIPE CLAY.\**

*External characters.* Colour, yellowish white ; fracture earthy ; feels smooth and greasy ; adheres to the tongue ; when kneaded with water becomes plastic and tenacious.

*Chemical characters.* Becomes white in the fire, but is infusible.

This is merely a pure kind of potter's clay.

*Localities.* Devonshire and Dorsetshire, Eng.

U. S. Martha's Vineyard, Mass.

*Uses.* Besides tobacco pipes, it forms the basis of queen's ware.

*Variety 13. POTTER'S CLAY.*

*External characters.* Colours, grey, greyish white, reddish, or bluish ; occurs massive in beds ; fracture earthy ; texture more or less compact ; sometimes friable ; soft and unctuous

\* Because tobacco pipes are made of it.

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What is said of cimolite and mountain meal ?—What are the colours, qualities, and uses of potter's clay ?

e touch ; when dry, receives a polish from the nail ; when tened and worked, it makes a very tenacious and ductile : sp. gr. from 1.08 to 2.

*Chemical characters.* Infusible. Some varieties, however, in a porcelain heat.

*Composition.* Silice 43.5 ; alumine 33.2 ; lime 3.5 ; iron water 18.—*Klaproth.*

is found in beds, or forming hills. It often contains or : remains of animals, fish, and plants.

*Uses.* This clay is employed in large quantities, in the manufacture of *stone ware*, consisting of pots, jugs, churns, &c. which are of a yellowish, or greyish white colour. When quite pure, it is necessary to mix with it a proportion of sand and flints, to *temper* it for the potter's use. When it contains a sufficient quantity of fine silicious matter, this becomes necessary.

Stone ware is glazed in the furnace, by throwing in a quantity of common salt, at a certain stage of the burning. It may also be glazed by a mixture of alkali, ground silex, and oxide of lead, spread on each vessel.

*Localities.* Devonshire, and Hampshire, in England, from whence large quantities are taken to supply the potteries at Devonshire and Newcastle.

S. Near Philadelphia, Penn. Burlington and Borden. N. J. of a good quality for pottery. Also in Maryland. Ma's Vineyard, Mass. It is white, and fit for pipe clay. Vicksburg, on the right bank of the Mississippi. This is an immense bed of 34 miles long, and from one to ten feet in thickness.—*Jessup.*

#### *Variety 14. LOAM.*

Loam or brick earth, varies very much in appearance, texture and composition. It consists of potter's clay mixed with a quantity of sand, carbonate of lime, oxide of iron, mica, &c.

It is the substance of which bricks are made, and is found almost every country.

#### *Variety 15. REDDLE. RED CHALK.*

*General characters.* Colour red, of different shades ; occasionally massive ; fracture conchoidal ; texture earthy ; structure often slaty ; soils the fingers, and leaves a bright red stain on paper ; opaque ; adheres to the tongue, and gives

It is said of red chalk ?

argillaceous odour when moistened ; falls to powder in water, but does not form a paste : sp. gr. from 3.13 to 3.93.

It seems to pass into red oxide of iron. It occurs in small masses in clay-slate and sandstone, of the more recent formations.

*Localities.* France, Germany, Siberia, &c. That used in commerce, is brought from Germany and France.

*Uses.* It is principally used for drawing. The coarser varieties are used by the carpenter, the finer by the painter.

It is either used in the natural state, or is pounded, washed, and mixed with gum, and cast into moulds. The crayons which are designed for small and delicate drawings, are mixed with a large portion of gum, in order to give them sufficient hardness.—*Jameson.*

*Species 35. FAHLUNITE.\**

*External characters.* Colours, dark reddish brown, streak greyish white ; occurs massive, and in thin layers ; opaque, or translucent on the edges ; yields to the knife ; scratches glass ; lustre waxy ; texture crystalline ; sometimes shows a tendency to form six-sided prisms.

*Composition.* Silica 46.74 ; alumina 26.73 ; magnesia 2.97 ; oxide of iron 5.11 ; water 12.5.—*Heisinger.*

*Locality.* Fahlun, in Sweden, embedded in a slaty talcose rock, in a copper mine.

*Species 36. HARMOTOME.*

*External characters.* Colours, greyish white, milk white, sometimes with a tinge of yellow, or red ; occurs in crystals which are rectangular four-sided prisms, terminated by rhombic planes, or four-sided pyramids ; solid angles often truncated ; crystals cross each other lengthwise, or so that the broad planes of one prism are perpendicular to the broad planes of the other. Crystals often compressed into a tabular form ; translucent, or transparent ; lustre pearly ; scratches glass ; structure foliated : sp. gr. 2.35.

Fig. 111.



Fig. 111. A compressed four-sided prism, terminated by a pyramid, consisting of four rhombic faces.

\* From its locality.

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What are the colours and crystalline forms of harmotome ?

Fig. 112



Fig. 112. A double, or twin crystal, consisting of two four-sided prisms joined together, and intersecting each other so as to make their axes coincide.

**Chemical characters.** Fusible into a diaphanous glass. On hot coals phosphoresces with a greenish light.

**Composition.** Silex 49; alumine 16; barytes 18; water 15.—*Klaproth*.

**Distinctive characters.** It does not, like zeolite, form a jelly with acids; arragonite is infusible; staurotide is of a deeper colour and infusible. Stilbite exfoliates on hot coals.

**Localities.** In the Hartz, it is found in metaliferous veins, with carbonate of lime, and sulphuret of lead. Also in Norway, Scotland, and Germany. It is a rare mineral.

*Species* 37. AMIANTHOIDE.\*

**External characters.** Colours, olive green, or greenish white; occurs in long capillary filaments, very flexible and elastic; lustre shining and silky.

**Chemical characters.** Fusible, with difficulty into blackish enamel.

**Composition.** Silex 47; lime 11; magnesia 7; oxide of iron 20; oxide of manganese 10.—*Vauquelin*.

**Distinctive characters.** It is more elastic than amianthus, and more flexible than asbestos. The result of its fusion, will also distinguish it from both.

**Locality.** Oisans, in France.

U. S. Topsham, Maine.—*Cleveland*.

*Variety* 1. BYSSOLITE.†

**External characters.** Colours, green, or brownish yellow; occurs in delicate filaments implanted on other minerals, standing erect, and somewhat resembling a kind of moss. These filaments are flexible and elastic.

**Composition.** Silex 34; alumine 43; lime 9; oxide of iron 19.—*Saussure*.

**Localities.** At the foot of Mount Blanc, and at Oisane, in France.

\* From resemblance to amianthus.

† From its resemblance to lichen or moss.

How is harmotome distinguished from zeolite?—How does amianthoide differ from amianthus?

*Species 38. AUGITE. PYROXENE.*

**External characters.** Colours, green, brownish, or blackish green, yellowish green, grey, and sometimes white; occurs in crystals, in grains, and amorphous; form, six or eight-sided prisms, terminated at each extremity by two principal faces; primary form, an oblique rhombic prism; cleavage parallel to the sides of this prism; lustre glimmering or splendid; opaque; scratches glass; structure foliated; fracture conchoidal, or uneven: sp. gr. from 3.15 to 3.57.

Fig. 113.

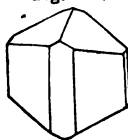


Fig. 113. A short four-sided prism, terminated by two principal faces, and truncated on the lateral edges.

Fig. 114.

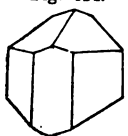


Fig. 114. A short six-sided prism, terminated by two faces, each face including the three lateral planes of the prism.

Sometimes it occurs in hemitrope crystals. It is subject to decomposition, by which it is reduced to a yellowish green, earthy mass.

Augite is found in primitive rocks, and in the productions of volcanoes. But whether in the latter case, it existed in the rock previously, and had passed the action of the volcanic fire unaltered, or whether its crystals are formed in the lava, after its ejection, is a matter of doubt and dispute, among geologists.

**Chemical characters.** Fusible, in small fragments, into a glassy globule, the colour of which, depends on that of the specimen.

**Composition.** Silica 54.86; lime 23.57; magnesia 16.49; protoxide of iron 4.44; manganese 0.42; alumina 0.21.—*Rose.*

**Distinctive characters.** It is commonly darker, and always harder, and heavier than olivine. Hornblende is more easily fusible than augite, sahlite is commonly more translucent, yenite fuses readily, and attracts the magnet. By these differences, this species may be distinguished.

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What are the colours of augite, and what are its crystalline forms?—What are the situations in which it is found?—What minerals does it most resemble?—What is the composition of augite?

*Localities.* Vesuvius, Etna, Stromboli, Teneriffe, Bourbon, &c. in volcanic products. Bohemia, Hungary, Transylvania, and Hesse, in Basalt. Norway, in primitive trap. North Wales, Scotland, England, &c. in trap and basalt.

U. S. Kingsbridge, N. Y. in primitive limestone. It is white.—*Bruce.* Litchfield, Conn. in whitish crystals, sometimes four inches long.—*Brace.* Also at Washington, and Brookfield, Conn. Deerfield, Mass. in black imperfect crystals. Eight miles from Baltimore, in white six-sided prisms. Also five miles from Baltimore, in six-sided prisms, of an olive green, or brownish red colour, and sometimes five or six inches long.—*Hayden.* Pittsfield, Mass.

The following minerals, are considered varieties of augite.

*Variety 1. DIOPSIDE.\**

*External characters.* Colours, green, greenish white, greyish, and yellowish white; occurs in crystals, of which the primitive form is an oblique rhombic prism; secondary forms, six, eight, or twelve-sided prisms, terminated by four or six faces; crystals longitudinally striated; translucent, or transparent; often compressed into tables; sometimes the crystals are fibrous, and are aggregated into radiating masses; structure foliated; scratches glass; lustre vitreous and shining: sp. gr. between 3.23 and 3.30.

*Chemical characters.* Fusible, with difficulty, into a greyish limpid glass.

*Composition.* Silica 57; magnesia 18.25; lime 16.5; oxides of iron and manganese 6.—*Laugier.*

*Distinctive characters.* It differs from augite and sahlite, in being more transparent, and of brighter green.

*Localities.* Mussa, in Piedmont, and hence it has been called *mussite*.

U. S. Phillipstown, N. Y. Pennsborough, Penn.

*Variety 2. PYRGOM. FASSAITE.†*

*External characters.* Colour, green, of various shades, often blackish green; occurs in crystals of six or eight sides; also in the form of an octohedron, or double four-sided pyramid, truncated on the edges; cleavage parallel to the sides of an oblique rhombic prism; crystals in confused groups; translucent or opaque; scratches glass.

\* From the Greek, signifying transparency.

† From the valley of Fassa.

---

What is diopside?



*Locality.* In the valley of Fassa, in the Tyrol.

*Variety 3. SAHLITE.\**

*External characters.* Colours, greyish green, or pale green; occurs in four or eight-sided crystals, with dihedral summits; also massive, and in granular concretions; structure of the massive lamellar, with joints parallel to the planes of an oblique prism; lustre shining, or glimmering; a whitish foliated substance often interposes between the natural joints; slightly unctuous to the touch; translucent or opaque; breaks easily into rhomboidal fragments: sp. gr. about 3.

*Chemical characters.* Infusible, or melts with difficulty into a porous glass. In small fragments with borax it does not melt, but seems to impart its colour to the glass.

*Composition.* Silica 53; alumina 3; lime 20; magnesia 19; oxide of iron and manganese 4.—*Vauquelin.*

*Distinctive characters.* Sahlite is of a paler green than augite, and less transparent than diopside, into which it passes. Fassaite occurs most commonly in crystals, sahlite rarely.

*Localities.* Sahla, in Sweden, in a silver mine. Arendal, in Norway, with iron, lead, and hornblende. Siberia, with beryl and mica.

U. S. Near lake Champlain, N. Y. Near Ticonderoga, N. Y. in green octohedral crystals of an inch in diameter.—*McEeven.* Near New-Haven, Conn. in serpentine. It is olive green and foliated.—*Silliman.*

*Variety 4. BAIKALITE.*

This substance receives its name from the lake Baikal, in Siberia, and was considered by Werner as a distinct variety. But no difference can be observed between it and sahlite. They are therefore considered to be the same mineral.

*Variety 5. COCCOLITE.†*

*External characters.* Colours, greyish, or bluish green, greenish black, red, or reddish brown; occurs in grains adhering together, and forming masses of irregular shapes; lustre vitreous and shining; scratches glass; translucent; grains angular, and easily separable by the fingers: sp. gr. from 3.30 to 3.37.

\* Because it was found at Sahla.

† From the Greek, a granular stone.

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Of what mineral are diopside, pyrgorm and sahlite varieties?—What is the composition of sahlite?—What is the appearance of coccolite?

**Chemical characters.** Fusible with ease, into a vitreous opaque globule.

**Composition.** Silex 50; alumine 1.5; lime 24; magnesia 10; oxide of iron 7; oxide of manganese 3.—*Vauquelin*.

The grains of this substance are of all sizes from that of the smallest sand, to that of a pea. Their form is angular, or rounded with irregular shining faces, often resembling crystals. In the same mass the different colours, red, green, &c. sometimes occur in distinct grains. Sometimes thin, white, and apparently silicious partitions run through the masses, and divide them into layers.

**Localities.** Arendal, in Norway, with iron and carbonate of lime. Antrim, in Ireland, disseminated in limestone.

U. S. West Chester, Ticonderoga, and Phillipstown, N. Y. Charlotte, Ver. At the last locality it is found in abundance, and of various colours.—*Hall*.

**Variety 6. WHITE COCCOLITE.**—(*Dr. Barratt*.)

**External characters.** Colour, clear white, or yellowish white; occurs in masses composed of angular grains of the size of gun shot.

**Locality.** Phillipstown, Putnam county, N. Y. The masses are interspersed with crystals of white augite.

This is a new variety, and was discovered by Dr. Barratt, in 1820.

Dr. Barratt also found at the same locality, rose coloured coccolite.—*Silliman's Journal*.

**Species 39. HORNBLende.**

**External characters.** Colour, dark bottle green, passing into black; occurs massive, crystallized and slaty; form of the primitive, an oblique rhombic prism; secondary form, a six-sided prism, variously modified; crystals striated and often flattened; sometimes distinct, but commonly aggregated, intersecting each other, or in confusedly radiating masses; opaque; lustre shining, sometimes pseudo-metallic; indents under the edge of the hammer; breaks with difficulty; fracture, foliated or fibrous; streak and powder, greyish green; yields to the knife: sp. gr. 3.15 to 3.38.

**Chemical characters.** Fusible, with ease, into a greyish black glass.

**Composition.** (Deep green.) Silex 47.21; alumine 13.94; lime 12.73; magnesia 21.86; oxide of iron 2.28; oxide of manganese 0.57; fluoric acid 0.90; water 0.44.—*Bonsdorff*.

Where is it found in this country?—What is the colour of hornblende?

There is a considerable variety in the composition of this species.

*Distinctive characters.* Schorl, which it resembles, is much harder, does not give a green streak and powder, and is generally found in distinct, nine-sided crystals. It differs from augite in being more easily fusible, softer and tougher.

Hornblende is a very abundant mineral. It is found chiefly in primitive rocks, but occurs more or less in secondary formations.

It frequently enters into the composition of granite, gneiss, and mica slate, and is an essential ingredient in syenite and greenstone.

*Localities.* U. S. Jerico, Ver. in long capillary crystals.—*Hall.* Franconia, Ver. in superb polished crystals, some of which are nearly half an inch broad, also in long and slender crystals, in a hornblende and serpentine rock. On the Schuylkill, Penn. in large masses, and in bladed, or acicular crystals.—*Lea.* Brunswick, Maine, fibrous hornblende occurs with white granular limestone.—*Cleaveland.*

*Variety 1.* MASSIVE HORNBLLENDE.

This variety presents a crystalline mass, consisting of long, straight, or curved fibrils, often intersecting each other, being closely compacted together. Sometimes the fibrils are twisted or curled, and appear like knots of wood, and sometimes like tufts of hair. It is very tough, and difficult to break. Colour as in the species.

*Variety 2.* HORNBLLENDE SLATE.

*External Characters.* Colour, greenish black ; occurs in beds, more or less extensive ; texture slaty, each layer being composed of fibres, interlacing, diverging, or curled into knots.

This variety agrees in all its characters with the massive, except in its slaty structure.

*Variety 3.* BASALTIC HORNBLLENDE.

*External characters.* Colours, black, brownish black, or jet black ; occurs in distinct crystals, in lava, volcanic scoria, and basalt ; opaque ; often moves the magnet ; crystals sometimes have a brilliant lustre ; structure foliated ; easily broken ; scratches glass : sp. gr. 3.25.

*Chemical character.* Melts with difficulty.

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What are the distinctive characters of hornblende ?—With what minerals is it associated ?—Is it a rare, or an abundant species ?

**Composition.** Silica 47 ; alumina 26 ; lime 8 ; magnesia 2 ; iron 15.—*Klaproth*.

**Distinctive characters.** It is of a more intense black, and has a much stronger lustre than common hornblende. Schorl is harder, and more easily broken. Its matrix also will generally distinguish it from other black crystals.

**Localities.** Saxony, Bohemia, Hungary, and other countries, where basalt and volcanic products exist.

*Variety 4. PARGASITE.*

**External characters.** Colour, light bottle green ; occurs crystallized in six-sided prisms, with dihedral summits ; also in rounded crystalline masses ; cleavage parallel to the lateral planes of a rhombic prism ; translucent ; scratches glass : sp. gr. 3.11.

**Chemical characters.** Fusible into a green glass.

**Composition.** Silica 42 ; alumina 14.1 ; lime 14.3 ; magnesia 18.3 ; oxide of iron 3.5 ; of manganese 1.0 ; water and fluorine acid 3.

**Distinctive characters.** This mineral resembles hornblende in every respect, except its lighter colour and translucency.

The specimen before me from Pargas, resembles in colour and translucency, some varieties of prehnite.

**Localities.** Pargas,\* in Finland, in calcareous spar.

U. S. Chester, Mass.

*Variety 5. HEDENBERGITE.*

**External characters.** Colours, greenish black, or dark brown, powder pale brownish green ; occurs in masses composed of shining plates ; fracture uneven ; fragments rhomboidal ; scratches carbonate of lime ; phosphoresces by heat and friction : sp. gr. 3.15.

**Chemical characters.** Fusible into a black shining glass, which is sometimes magnetic.

**Composition.** Silica 40.63 ; alumina 0.37 ; water 16.5 ; protoxide of iron 35.25 ; oxide of manganese 0.75 ; carbonic acid 4.93.—*Hedenberg*.

**Locality.** Tunaberg, in Sweden, in calcareous spar, with iron pyrites, quartz, and mica.

This variety seems to differ from common hornblende, chiefly in the form under which it occurs.

\* Whence the name pargasite.

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How does the basaltic, differ from the common hornblende ?—To what species do pargasite and hedenbergite belong ?

Pinkerton quotes several authors to prove that mountains of hornblende exist in several parts of the world. Patrin, he says, observed in Siberia, many mountains entirely composed of it, with occasional veins, or masses of granite.

*Species 40. TREMOLITE.*

Tremolite occurs massive, crystallized, fibrous, and granular. Its colours are generally white, and greyish, or yellowish white; lustre shining, vitreous, or silky; it affords several varieties, depending chiefly on the different forms.

*Variety 1. CRYSTALLIZED TREMOLITE.*

*External characters.* Colour, white, often with a tinge of grey, yellow, or red; occurs in crystals, which are either very flat four, six, or eight-sided prisms, deeply striated, or minute fibres, the forms of which, it is difficult to determine; crystals seldom well defined, but commonly compressed; translucent, sometimes nearly transparent; very brittle; harsh to the touch; lustre glistening or silky; scratches glass: sp. gr. about 3.

*Chemical characters.* Fusible, in small particles, into a porous white enamel.

*Composition.* (Fibrous.) Silica 65; lime 18; magnesia 10.33; water and carbonic acid 6.5; oxide of iron 0.16.—*Klaproth*.

The carbonic acid in the above analysis probably came from the gangue, which is commonly limestone or dolomite.

*Distinctive characters.* It may resemble asbestos, but tremolite is very brittle, while asbestos is flexible. It never has the green colour of actynolite. The foliated structure of stilpnomelane and the electrical powers and chemical qualities of zeolite, will distinguish them from tremolite.

*Variety 2. FIBROUS TREMOLITE.*

*External characters.* Colour, white, often very pure and pearly; occurs in masses consisting of fine delicate fibres, sometimes long and straight, or gently curved, and sometimes branching; lustre silky; fibres separable by the fingers; harsh to the touch; friable sometimes between the fingers, in which case it is apt to penetrate the skin.

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What is the prevailing colour of tremolite?—How is tremolite distinguished from asbestos?—What is the appearance of fibrous tremolite?

Fig. 115.



Fig. 115, represents the common appearance of fibrous tremolite.

*Distinctive characters.* This variety resembles fibrous gypsum, but gypsum instantly becomes opaque, when heated, and falls in pieces.

**Variety 3. BLADED TREMOLITE.**

*External characters.* Colours, white, or yellowish, or bluish white; occurs in long flattened prismatic crystals, resembling in form the blade of a double-edged knife; translucent; traversed by cross fissures; easily broken; several inches long. These are flattened, four or six-sided prisms.

**Variety 4. PYRALLOLITE.\***

*External characters.* Colour, greenish, becomes white by long exposure; occurs massive, and in crystals; form, the flat rhombic prism, resembling the bladed variety of tremolite; crystals an inch or more long; fracture dull and earthy; cleaves into triangular prisms, but not with shining faces; opaque, or in thin laminæ, translucent: sp. gr. 2.57.

*Chemical characters.* Becomes black, then white, and the edges are reduced to a white enamel. In powder, phosphoresces on hot iron.

*Composition.* Silica 56.6; alumina 3.4; lime 5.6; magnesia 23.4; oxide of iron and manganese 1.1; bituminous matter and loss 6.4.—*Nordenskiöld.*

*Localities.* Pargas, in Finland, in foliated limestone.

U. S. Kingsbridge, N. Y. in limestone.—*Nyctall.*

\* From the Greek, signifying change by fire, in allusion to its turning black or white under the blowpipe.

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What are the varieties of tremolite?

*Variety 5. CALAMITE.\**

*External characters.* Colour, light green; occurs in rhombic prisms, striated longitudinally; translucent; cleavage parallel to the sides of a rhombic prism; soft; resembles tremolite in the form of its crystals, which are traversed by fissures.

*Locality.* Normark, in Sweden, with oxide of iron.

Tremolite is a common and abundant mineral. It is found in limestone, and particularly in that variety called *dolomite*. It was first found in the mountains of Tremola, in Switzerland, whence the name.

*Localities.* Its foreign locations are very numerous. Beautiful specimens come from St. Gothard, in Switzerland.

U. S. Litchfield and Washington, Con. Beautiful specimens of the bladed and fibrous varieties are found at both places in dolomite. Also at Milford, Canaan, and Goshen, Con. Newbury and Bolton, Mass. Great Barrington and Sheffield, Mass. At Sheffield the fibres are two feet long.—*Dewey*. Wardsborough and Bellows Falls, Ver. Near Baltimore, Md. East Marlborough, Penn. fibres a foot long.—*Jessup*. Kingsbridge and Tarrytown, N. Y. Smithfield, R. I. very beautiful.—*Webb*. West Marlborough, Penn.

*Species 41. ACTYNOLITE.*

*External characters.* Colours, green, sometimes deep and beautiful, also dark green and brownish; occurs in single, long, straight, four-sided flattened prisms, crossing each other at various angles, and in fibrous masses, either radiated or curved; lustre highly shining; crystals often deeply striated; translucent; scratches glass; brittle: sp. gr. from 3 to 3.30.

*Chemical characters.* On the first application of the heat, it turns deep brown, afterwards becomes ash grey, with the edges glazed with a black enamel; tinges borax light green.

*Composition.* Silica 50; alumina 0.75; lime 9.75; magnesia 19.75; oxide of iron 11; oxide of chrome 3; of manganese 0.5; potash 0.5; water 5.0.—*Laugier*.

*Distinctive characters.* Its colour will distinguish it from hornblende and tremolite, both of which it very nearly resembles in form. Epidote is of a lighter, or yellowish green, and zeolite is greyish white.

\* From *Calamus*, Latin, a reed, from the appearance of the crystal.

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Is tremolite a common, or rare mineral?—Whence comes the name-tremolite?—What is the colour of actynolite? How is it distinguished from tremolite and hornblende?

**Variety 1. BLADED ACTYNOLITE.**

*External characters.* Colour, deep green, often of various shades in the same crystal; occurs in long, slender, flat, four or six-sided crystals, with alternate sharp lateral edges, and often deeply striated; summits commonly incomplete; translucent; lustre shining; brittle; commonly occurs in talc, crystals crossing each other at various angles.

Fig. 116.

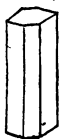


Fig. 116. A flat six-sided prism, the common form.

Fig. 117.



Fig. 117. The same with the lateral edges truncated.

**Variety 2. ACICULAR ACTYNOLITE.**

*External characters.* Colour, lighter green than the bladed; occurs in capillary crystals, closely aggregated, and either parallel, intersecting, diverging, or radiating from a centre; lustre glistening; opaque; harsh to the touch; brittle and inelastic.

**Variety 3. GLASSY ACTYNOLITE.**

It differs from the above variety, in possessing a vitreous, or glassy lustre.

**Variety 4. ASBESTIFORM ACTYNOLITE.**

*External characters.* Colour, greenish grey; occurs in slender, somewhat elastic, fibrous crystals, closely aggregated; lustre silky; fibres parallel or diverging, and easily separable by the fingers; very brittle.

*Distinctive characters.* It resembles amianthus, but is easily known from it, by its brittleness.

**Variety 5. MASSIVE ACTYNOLITE.**

*External characters.* Colour green, occurs in lamellar masses, composed of granular concretions; structure foliated; also disseminated in other minerals.

What are the crystalline forms of actynolite?—What are the varieties of actynolite?



Actynolite is found in primitive rocks, as granite, mica slate, and in veins of talc.

*Localities.* Tyrol, and St. Gothard, in long six-sided prisms. Norway, Saxony, Piedmont, England, Scotland, and most other countries.

U. S. Bolton, Middlefield, Hawley, and Chelmsford, Mas. Windham, Vt. in compressed four-sided prisms, sometimes five inches long.—*Hall.* Brunswick, Maine, in all its varieties.—*Cleaveland.* Near New Haven, and also at Litchfield and Canton, Conn. Near Baltimore, Md. in all its varieties. Concord, Penn. in large masses.—*Conrad.* On the Island of New York, N. Y. Near Philadelphia, Penn.

*Species 42. HYPERSTHENE.*

*External characters.* Colour, blackish green, or dark brown; occurs massive; structure lamellar; cleavage parallel to the sides, and shorter diagonals of a rhombic prism; lustre, when viewed in certain directions, greenish, in others, copper red, and strongly metallic; opaque or translucent on the edges; powder, dark greenish grey; yields to the knife slightly, scratches glass.

*Chemical characters.* Fusible on the sharp edges; with borax, gives a dark green glass.

*Composition.* Silica, 54.25; magnesia, 14.0; alumina 2.25; lime 15; oxide of iron, 24.5; water 1.—*Klaproth.*

*Localities.* Hypersthene was first found on the coast of Labrador, and hence has been called *Labrador hornblende*. It occurs, forming a constituent of a rock, with Labrador felspar. It is also found in Greenland.

U. S. On Brandywine creek, Penn. colour dark green; lustre metallic.—*Jessup.* Hingham, Mass. with hornblende. Essex, N. Y. crystals two or three inches long, colour greyish brown.—*Hall.*

*Uses.* It is sometimes cut and polished for ringstones, and brooches.—*Cleaveland.*

*Species 43. METALLOIDAL DIALLAGE.*

*External characters.* Colours, bottle, emerald, or olive green, metallic grey, brownish, or nearly white; occurs massive; structure lamellar, sometimes curved; lustre metallic; opaque; colours suddenly appear and disappear as the specimen is turned towards the light, in this respect resembling the Labrador felspar: sp. gr. about 3.

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Is actynolite a common mineral?—What is the colour of hypersthene? What is the use of hypersthene?

*Chemical characters.* Fusible with difficulty into a blackish enamel.

*Composition.* Silex 41; alumine 3; lime 1; magnesia 29; oxide of iron 14; water 10.—*Drappier*.

It is commonly found in serpentine.

*Localities.* Tyrol, Saxony, Scotland, England.

U. S. Near Haverstraw Bay, N. Y.—*Schaeffer*. Middlefield, Mass.

*Species 44. GREEN DIALLAGE. SMARAGDITE.*

*External characters.* Colour, brilliant emerald green, or grass green; occurs massive and disseminated; structure foliated; cleavage parallel to the sides and diagonals of a slightly rhombic prism; opaque or translucent; lustre of the laminæ, pearly or silky; scratches carbonate of lime: sp. gr. about 3.

*Chemical characters.* Fusible with difficulty into a grey, or greenish enamel.

*Composition.* Silex 50; alumine 21; lime 13; magnesia 3; with a little oxide of iron and chrome.—*Vauquelin*.

It seldom or never occurs in distinct crystals.

*Localities.* On the banks of the Lake of Geneva, in saussurite. Near Turin. Corsica and Switzerland.

U. S. Crown Point, N. Y.—*Gibbs*. New Haven, Conn. in serpentine.—*Hall*.

*Species 44. ASBESTOS.*

There are several varieties of this mineral, which differ considerably in their external characters, but they generally agree in possessing a fibrous structure, more or less a vegetable appearance, and in being infusible in a common fire.

*Variety 1. AMIANTHUS.*

*External characters.* Colours, white, yellowish, silver grey, greenish, and reddish; occurs in long threads or plates, easily separable; lustre silky; somewhat unctuous to the touch; soft, flexible, and elastic; fibres usually straight, often resembling raw flax, and sometimes the finest silk.

*Chemical characters.* Becomes white, brittle, and opaque, and then melts into a white enamel; gives a diaphanous glass with borax.

*Composition.* Silex 59; alumine 3; lime 6; magnesia 29.—*Chenevix*.

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What is the appearance of green diallage?—Does it occur in crystal or not?—In what form is amianthus found?

**Distinctive characters.** It resembles amianthoide, byssolite and common asbestos. The two first are fusible in a black enamel and tinge borax green. Asbestos is inflexible; the others are flexible.

It is found in veins, in serpentine.

**Localities.** Corsica, in great abundance. Savoy, fibres a foot long. Pyrennees, Cornwall, &c.

U. S. Hoboken, N. J. Staten Island, N. Y. it is uncommonly beautiful. The fibres are sometimes more than two feet long.—*Pierce* and *Torrey*. New Haven, Conn. in serpentine; also at New Milford. Some specimens are exceedingly soft and fine. Kellyvale, Ver. Mount Holly, Mass. very abundant.—*Hall*.

**Uses.** It is said that the ancients preserved the ashes of their dead, by wrapping their bodies in cloth made of this substance, before they were committed to the funeral pile. It was also used for incombustible wicks; but is now considered chiefly as a curiosity.

In Siberia it is said to be manufactured into various articles, as gloves, purses, &c. Incombustible paper has also been made of it, and if it be a fact, that *ultra-marine blue*, will “stand proof by fire;” as it was anciently advertised to do, we should have the materials for making incombustible records, an improvement of great consequence to the world.

Cloth is made by mixing the amianthus with flax, and spinning and weaving the mixture in the usual way, after which the flax is burned out, and the incombustible cloth remains. When such cloth requires cleaning, it may be thrown into a fire, and moderately heated for a few minutes. A strong heat would render it brittle.

#### *Variety 2.* COMMON ASBESTOS.

**External characters.** Colours, greenish grey, green, or yellowish grey; occurs massive, composed of fibres of various lengths, either straight, curved, or radiating from a centre; often appears nearly compact from the close aggregation of its fibres; fracture splintery or fibrous; fibres inflexible and inelastic; translucent on the edges: lustre shining: sp. gr. from 2.54 to 3.

**Chemical characters.** Easily fusible into a dark enamel.

**Composition.** Silica 63.5; magnesia 16.0; lime 12.8; alumina 1.1; oxide of iron 6.—*Bergman*.

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What are the uses of amianthus?—What is said of incombustible cloth and paper?

*Distinctive characters.* Its inelasticity will distinguish it from amianthus, and its softness, particularly in powder, from tremolite and actynolite.

It is usually found in serpentine.

*Localities.* Sweden, Hungary, Uralian mountains, &c.

U. S. On the summit of the Green mountains, Vt.—*Hall*. New Castle county, Del. in abundance. On the Island of New York, N. Y. Also on the banks of the Hudson. Washington, and near New Haven, Conn.

#### *Variety 3.* MOUNTAIN CORK.

*External characters.* Colours, grey, brown, yellowish brown, or pale yellow; occurs in amorphous, or flattish pieces; structure fibrous, with the fibres interlacing each other in every direction; it is somewhat elastic, and so light as to swim in water.

#### *Variety 4.* LIGNIFORM ASBESTOS.

*External characters.* Colours, brownish, or yellowish; occurs massive, structure fibrous, often much resembling chips of wood; it is hard, the fibres rigid, sometimes straight, but often interwoven, curved or radiated; opaque and dull: sp. gr. about 2.

*Chemical characters.* Fusible with difficulty, into a black slag.

*Localities.* U. S. Mount Holly, Ver. Newlin township, Pennsylvania.

#### *Variety 5.* MOUNTAIN LEATHER.

*External characters.* Colours, brown, reddish white, or reddish; occurs in flat layers composed of fibres, straight, or curved; opaque; layers sometimes separable; has more or less the aspect of leather.

*Locality.* Washington, Conn.

#### *Variety 5.* MOUNTAIN PAPER.

*External characters.* Colour, white; lustre silky, or pearly; separable into thin layers, having the aspect of paper.

*Locality.* Washington, Conn.

#### *Species 46.* SAPPHIRE.

*External characters.* Colours, blue, red, violet, yellow, green, and chatoyant; also limpid; occurs crystallized, and in rolled pebbles and angular fragments; primary form the rhomb; secondary forms the regular six-sided prism, often

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How is common asbestos distinguished from amianthus?—What are the varieties of common asbestos?—What are the colours of the sapphire? What are the forms of its crystals?

truncated, and the double six-sided pyramid, or dodecahedron; also modified by truncation; transparent or translucent; hardness only inferior to that of the diamond; fracture conchoidal; cleavage indistinct: sp. gr. about 4.

Fig. 118.



Fig. 118. A double six-sided pyramid.

A short six-sided prism, with the solid angles alternately truncated, is also a common form.

*Chemical characters.* Infusible alone, but loses its colour. With borax slowly dissolves into a colourless glass.

*Composition.* Alumine 98.5; lime 0.5; oxide of iron 1.  
—*Klaproth.*

The varieties of sapphire depend on its different colours.

*Variety 1.* BLUE SAPPHIRE. (Oriental Sapphire.)

*External characters.* Colour, azure, or indigo blue; translucent, or transparent.

The colour of this variety often differs in the same specimen, some parts being deep blue, while others are nearly colourless.

*Variety 2.* RED SAPPHIRE. (Oriental Ruby.)

*External characters.* Colour, blood red, passing into aurora, or rose red; cleavage more distinct than in the blue variety; sometimes chatoyant, translucent or transparent.

*Variety 3.* ASTERIATED SAPPHIRE.

*External characters.* Colours, reddish, or violet. When cut in a certain manner, it shows a silvery star, of six rays.

The term *oriental*, merely signifies that the stone comes from the east, and as most of the gems come from the eastern quarter of the globe, dealers in these articles often attach this epithet to the name of the stone, in order to raise its value.

In addition to the above varieties, lapidaries make the following distinctions. The violet sapphire, is called *Oriental Amethyst*, the yellow sapphire, *Oriental Topaz*. Green sapphire, *Oriental Emerald*.

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What are the varieties of sapphire?—What is the composition of the sapphire?—What does the term *oriental*, signify, as applied to the sapphire?

Sapphires are found in alluvial earths, and in the sand of rivers, generally at the foot of primitive mountains. Their matrix is primitive rock, as granite and gneiss, though it has seldom been found in its native situation.

*Localities.* The finest are found in Pegu, on the Island of Ceylon, and in the kingdom of Ava, in the East Indies. It occurs also in Bohemia, France, Switzerland, and Portugal.

The sapphire is often mentioned in Scripture, and was the fifth stone in order, on the high priest's pectoral, or breast-plate of judgment, having the name of Simeon inscribed upon it.

Pliny says, that the best sapphires come from Media: perhaps from Mount Sephar, mentioned by Moses. Calmet says, that *Shaphir* in Hebrew, which he translates *sapphire*, signifies beauty, and that the orientals had an extraordinary esteem for this stone. Those who wore it about them thought it to be the occasion of their happiness and good fortune.

*Uses.* The sapphire is ranked among the most valuable of gems. It yields in hardness only to the diamond, and is employed in the finest kind of jewelry. It is also employed for jewelling the pivot holes of chronometers, and other astronomical instruments.

No ancient engravings exist on this stone, probably because its hardness is such, as to resist, like the diamond, the ancient means of engraving gems.

Since diamond dust has been used for cutting hard stones, the sapphire has been employed by a few artists. Caldore engraved a portrait of Henry IV. of France, on a sapphire, which was in the cabinet of the Duke of Orleans, and one or two German artists have tried their skill upon it.

The red variety is most esteemed under the name of *oriental ruby*.

The price of the oriental ruby is estimated by carats, after the manner of estimating the diamond.—(*See Diamond.*)

A perfect ruby, above three and a half carats or fourteen grains, is more valuable than a diamond of the same weight. If the weight be one carat, it is worth ten guineas, two carats forty guineas, three carats, one hundred and fifty guineas, six carats, above one thousand guineas. It is said, that in the throne of the Great Mogul, there are one hundred and eight oriental rubies, weighing from one hundred to two hundred carats each.

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Where are the finest sapphires found?—In what situations are these stones found?—How is the value of the sapphire estimated?

A blue sapphire of good quality, weighing ten carats, is worth fifty guineas, one of twenty carats, is worth two hundred guineas.

Among the crown jewels of France is a ruby weighing one hundred and sixty-six carats. At ten guineas the carat, this would be worth two hundred seventy-five thousand, five hundred and sixty guineas. It is said that the lapidaries expose the light-blue varieties to a certain degree of heat, when they become white, and are worn instead of the diamond.

The sapphire is cut with diamond dust, and polished with emery.

*Species 47. CORUNDUM.*

*External characters.* Colours, greenish, greyish green, reddish, yellowish, bluish, brown, or white; occurs in six-sided crystals, in rolled pieces, also granular and amorphous; structure foliated; cleaves into rhomboidal fragments; lustre shining; translucent or opaque: sp. gr. nearly 4; hardness nearly equal to that of sapphire.

*Chemical characters.* Infusible. Fusible by the compound blowpipe.—*Silliman.*

*Composition.* Alumine 85.5; silice 7; oxide of iron 14.—*Chenevix.*

*Distinctive characters.* The extreme hardness of this mineral, will distinguish it from all others which it resembles.

*Localities.* India, in the kingdom of Ava, on the coast of Malabar. At Bengal, in China, Thibet, &c. It is accompanied with garnet, fibrolite, zircon and magnetic iron.

That of China and Ava is brown, or greenish, and sometimes nearly black. That of the Carnatic is blue, or reddish purple. That of Thibet is reddish brown, often coated with steatite.

The variety which comes from China was formerly called *adamantine spar*.

U. S. Laurens District, S. C. a six-sided prism has been found. Litchfield, Conn. in cyanite. It is greyish blue, and occurs massive and in six-sided prisms.—*Brace.*

*Uses.* It is employed like emery, for the polishing of hard stones and metals.

*Variety 1. EMERY.*

*External characters.* Colours, blackish or bluish grey, powder brownish black; occurs massive; structure finely granular; fracture uneven, or splintery; opaque; lustre a

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What is the colour of corundum?—In what form does it occur?

tile glistening, or somewhat metallic ; hardness equal to corundum ; conducts electricity : sp. gr. 4.

*Composition.* Its constituents are the same as those of corundum.

*Localities.* Saxony, in steatite. Naxos, in the Archipelago, where it is found in abundance, in fragments, or rolled pieces at the foot of a primitive mountain. Italy, Spain, East Indies, and Ireland.

The emery of commerce, is chiefly from Naxos.

*Uses.* It is employed almost universally in cutting and polishing stones, steel, &c. For this purpose it is reduced to powder in a steel mill.

Even the sapphire and oriental ruby, the hardest substances, next to the diamond, yield to emery when placed on the lapidary's wheel.

#### *Species 48. DIASPORE.\**

*External characters.* Colour, greenish grey ; occurs massive, consisting of laminæ slightly curved, and easily separated ; occurs also in cellular masses, consisting of slender crystals ; lustre pearly ; translucent in thin laminæ ; also, though rarely, in separate crystals, in form of a doubly oblique prism : sp. gr. 3.43.

*Chemical characters.* In the flame of a candle, it crackles, and is dispersed into minute fragments, or spangles. It is infusible alone ; with borax melts into a colourless glass.

*Composition.* Alumine 80 ; water 17 ; iron 3.—*Vauquelin*.

Nothing is known of its geological situation.

When heated in a retort, it decrepitates violently, and splits into small white brilliant scales.—*Phillips*.

#### *Species 49. TURQUOISE.*

*External characters.* Colour, bluish green, passing into sky blue, and apple green ; occurs in reniform masses, from the size of a nut to that of a goose's egg ; opaque ; powder white ; lustre waxy, or dull ; fracture conchoidal ; not so hard as quartz ; decomposes on the outside, when it resembles porcelain clay : sp. gr. about 3.

*Chemical characters.* Infusible alone ; with borax melts into a limpid glass. Suffers no change with acids.

\* From the Greek, in allusion to its being dispersed by heat.

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Of what species is emery a variety ?—What is the colour of turquoise ? what form does it occur ?



**Composition.** Alumine 73 ; water 18 ; oxide of copper 4.5 ; oxide of iron 4.—*Johns.*

**Localities.** Persia and Turkey, in alluvial soils.

A kind of turquoise, which for distinction is called *occidental turquoise*, is found near the town of Simore, in Lower Langue-doc. This is supposed to consist of horns, or teeth of animals, penetrated and coloured by oxide, or carbonate of copper. This variety consists chiefly of phosphate of lime.

**Uses.** The oriental turquoise receives a fine polish, and is much esteemed for ring stones, bracelets, watch ornaments, &c. It is greatly esteemed by the Persians, who work it into handles for sabres, &c.

The ancients, especially the Egyptians, held this stone in great estimation. Some fine engravings were executed on it, but it was considered much too soft for this purpose.

This stone is so nearly imitated by the French lapidaries as to make it difficult to discover the difference.

**Species 50. GIBBSITE.\*—Torrey.**

**External characters.** Colours, greenish, yellowish, or greyish white ; occurs in irregular stalactical masses, with a knobby surface, from one to three inches in length, and an inch in diameter ; presenting an aggregation of elongated tuberoso masses, somewhat resembling those of prehnite ; structure fibrous, radiating from the centre ; translucent on the edges ; easily reduced to powder ; harder than calcareous spar : sp. gr. 2.40.

**Chemical characters.** Infusible, but whitens. Does not effervesce with acids.

**Composition.** Alumine 64.8 ; water 34.7.—*Torrey.*

This is a new mineral.

**Localities.** U. S. Richmond, Mass. in a neglected mine of brown hæmatite, where it was first discovered by Dr. Emmons. Also at Pittsfield, Mass.

**Species 51. FIBROLITE.†**

**External characters.** Colours, white, or greyish white ; occurs in minute fibres, closely united, and crossing each other in various directions ; harder than quartz ; form indeterminate ; electric by friction : sp. gr. 3.2.

\* In honour of Col. Gibbs.

† Because it occurs in fibres.

---

What is the use of turquoise ?—What is the colour and what the form of Gibbsite ?—Where was Gibbsite first discovered ?

**Chemical characters.** Infusible. Emits a phosphoric light, when two pieces are rubbed together.

**Composition.** Alumine 58.25 ; silic 38 ; iron 0.75.—*Chenevix.*

**Localities.** It is found with corundum in the Carnatic and China. It is a rare mineral.

U. S. Cummington, Mass.—*Nuttall.* Saybrook, Conn.—*Nuttall.*

*Species 52. PINITE.*

**External characters.** Colours, brown, blackish brown, or grey ; occurs in crystals only ; form the regular six-sided prism, variously modified by truncation ; sometimes four of its sides are extended, while the others are diminished, giving it the aspect of a four-sided prism with bevelled edges ; sometimes it is truncated so as to appear as a twelve-sided prism ; structure foliated ; lustre glistening, sometimes slightly metallic ; fracture splintery ; powder unctuous ; odour argillaceous ; opaque or translucent on the edges : sp. gr. 2.98 ; yields to the knife.

Fig. 119.

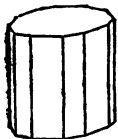


Fig 119. A twelve-sided prism ; or a six-sided prism so truncated as to give twelve faces.

**Chemical characters.** Infusible, but becomes glazed on the edges.

**Composition.** Alumine 63.75 ; silic 25.9 ; oxide of iron 6.75.—*Klaproth.*

**Distinctive characters.** The form of its crystals, which often appear round, will distinguish it from most other minerals. Some specimens have the aspect of mica. It is softer than scapolite or cyanite.

**Localities.** Saxony, in a mine called *Pini*, whence its name. France, Savoy, Cornwall, &c.

U. S. Haddam, Conn. in a micaceous rock, crystals several inches long.—*Silliman.* Bellows Falls, N. H. in cylindrical crystals.—*Hall.* Lancaster, Mass. in six-sided prisms.

---

What is the appearance of pinite ?—What is its composition ?

mass; base partly ; sometimes glass ; yields a  
mass of gr. 2.50.

Fig. 120.



Fig. 120. A four-sided lamellar  
two broad and two narrow faces.

*Physical characters.* Infusible, but turns white

*Composition.* Alumina 55.5 ; silica 43 ; oxide

*Properties.*

*Crystals or Scales.* generally occurs in long  
crystals closely aggregated, and crossing, or stand  
alone as to present a singular and curious aspect  
of the crystals are curved, others are corrugated,  
as though they had been pressed endwise, or had  
sprung themselves at full length, others are pressed  
into shapes, &c.

It is found in primitive rocks, especially in gran  
ites. Switzerland, Tyrol, Spain and Hu

U. S. Several places in Maryland. Chester (

near Conway, and several other places in Penn.

Massachusetts, Middle Haddam, and near New Ha

That of Litchfield is of a fine azure blue. That

of a brown. Chesterfield, Mass. imperfect crystal

see also page. — Webster. Conway, Granville, D

*Species 54. STAUROTIDE.*

*External characters.* Colour, reddish brown; occurs crystallized, in six-sided prisms, terminated by dihedral summits, but variously modified by truncation; crystals often cross, intersect each other; lustre, sometimes shining, with a tooth surface, and sometimes rough and dull; scratchesartz; opaque or translucent.

g. 121.

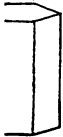


Fig. 121. A single six-sided prism, the common form.

Fig. 122.

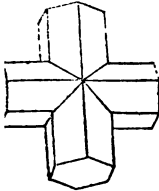


Fig. 122. Two six-sided prisms united in the form of a cross. This is not an uncommon form.

*Chemical characters.* Infusible alone; dissolves slowly with *ax*, giving it a greenish tinge.

*Composition.* Alumine 52.25; silic 27; oxide of iron 50; oxide of manganese 0.25—*Vauquelin*.

*Distinctive characters.* Its colour resembles the garnet, its form and infusibility will distinguish them. Titanite has a metallic lustre and a different form, and pinite differs from it in form and colour.

Staurotide is found most frequently in mica-slate, and sometimes in granite, and gneiss.

*Localities.* U. S. Bolton, Litchfield, Harwinton, and Idam, Conn. Near Baltimore, Md. Sheffield, Northfield, Framington, and Middlefield, Mass. Chester and Putney, N. H. Near the city of New York, N. Y. Winthrop, Sidney, and Hallowell, Maine.

*Species 55. AUTOMOLITE.*

*External characters.* Colours, dark bluish green, or black-green; occurs in octohedrons, or hexahedrons, variously

What is the colour of staurotide?—Under what form does its crystals occur?—What minerals does it resemble?

modified by truncation ; faces of the crystals often unequal, sometimes mackled ; cleavage parallel to all its planes ; scratches glass ; lustre shining and resinous ; opaque, or translucent on the edges ; sp. gr. 4.26 to 4.69.

*Chemical characters.* Infusible alone ; in powder, with borax gives a greenish glass.

*Composition.* Alumine 42 ; silice 4 ; oxide of zinc 28 ; oxide of iron 5 ; sulphur 17.—*Vauquelin.*

*Distinctive characters.* It is heavier and not so hard as spinelle ruby, and pleonaste ; garnet is fusible.

*Localities.* Fahlun, in Sweden, in a talcose rock.

U. S. Franklin Iron Works, N. J.—*Phillips.*

*Species 56. TOPAZ.*

*External characters.* Prevailing colour, wine yellow, of various tints, also bluish, greenish, lilac, and white ; occurs crystallized, in rolled pieces, and massive ; form, a six, eight, or ten-sided prism, with various and dissimilar terminations ; structure lamellar ; cleavage parallel to the sides of a right rhombic prism ; often electric by heat ; fracture small conchoidal ; lustre vitreous ; scratches quartz ; translucent, or nearly limpid : sp. gr. 3.5.

Fig. 123.

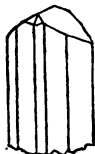


Fig. 124.

Fig. 123. An eight-sided prism, terminated by four unequal planes.



Fig. 124. The same with the solid angles replaced by truncation.

*Chemical characters.* Infusible, but after long heating becomes opaque ; with borax melts into a limpid glass.

*Composition.* (Yellow Brazilian.) Alumine 47.5 ; silice 44.5 ; fluoric acid 7 ; oxide of iron 0.5.—*Klaproth.*

In the composition of this species, there is a considerable variety.

What is the colour of topaz ?—What are the forms of its crystals ?  
What is the composition of topaz ?

*Distinctive characters.* It is harder than citrine, which is infusible with borax. The greenish Siberian topaz becomes electric by heat, and not by rubbing. The emerald and beryl are not electric at all. From coloured glass, which is often sold for real topaz, it may be distinguished by a fine file, which will scratch the paste, but not the topaz.

Topaz belongs to primitive rocks.

*Localities.* Siberia, Saxony, Bohemia, Brazil, Savoy. Cornwall, Eng. and Aberdeenshire, Scotland.

U. S. Huntington, Conn. Colour, honey yellow ; structure foliated. One crystal from this locality weighed  $1\frac{1}{2}$  lbs. and a fragment of another 2 lbs. 1 oz.—*Hitchcock*. Goshen, Mass. This locality was discovered by the Rev. Mr. Hitchcock. It exactly resembles the limpid topaz of Rio Janeiro.

The largest crystal of topaz, probably ever in Europe, weighs 7 ounces, and was found in Aberdeenshire.—*Jameson*.

The topaz was known to Moses. But whether it was the same which we call by that name may admit of doubts. The ancient topaz was of a green colour. Pliny says it was first found by king Juba, but whether he means the same stone with that mentioned by Moses, is also uncertain.

The topaz was the second of the first row in the Jewish pontifical breast-plate, with the name of Simeon inscribed on it.

*Uses.* The yellow variety is chiefly employed in jewelry, and when of an equal colour, and without flaws, it is considerably esteemed, though much too common to be highly valued by the lapidaries.

The ancients engraved on the topaz, of which a few examples still remain. In the imperial library at Paris, there is a beautiful intaglio on this gem, representing an Indian Bacchus. The cabinet of the emperor of Russia also contains several portraits of emperors, and empresses, on the same stone.

The topaz is polished on a copper wheel with tripoli and spirits of wine.

#### *Variety 1.* PYROPHYSALITE.

*External characters.* Colours, greenish white, or pale bluish green ; occurs in small roundish masses, and in crystals ; translucent or opaque ; structure lamellar in one direction ; fracture uneven or conchoidal ; lustre glimmering ; not so hard as quartz : sp. gr. 3.4.

---

Where has topaz been found in this country ?—Was topaz known to the ancients ?

**Chemical characters.** It intumesces, and gives out a greenish phosphoric light.—*Phillips*.

**Composition.** It is composed of nearly the same ingredients as topaz.

**Localities.** Fahlun and Finbo, in Sweden.

U. S. Goshen, Mass.

*Species 57. PYCNITE.*

**External characters.** Colour, dull yellowish, or reddish white; occurs in long six-sided prisms, longitudinally striated; crystals closely aggregated laterally; possesses no regular structure; full of transverse rents; lustre shining; scratches quartz; translucent; brittle; electric by heat: sp. gr. 3.5.

**Chemical characters.** Infusible alone; with borax slowly dissolves into a limpid glass.

**Composition.** Alumine 60; silice 30; lime 2; fluoric acid 6; water 1.—*Vauquelin*.

**Localities.** Altenberg, in Saxony. Bavaria, Bohemia, Norway, Siberia, &c.

U. S. Chester, Mass.

*Species 58. CHRYSOBERYL.\**

**External characters.** Colour green, with a yellowish or brownish tinge, sometimes reflects a whitish light, which appears to come from the interior of the crystal; occurs massive, crystallized, and in rolled pieces; form, a short, broad, four or six-sided prism, or table, terminated by four or six-sided summits; translucent, or nearly transparent; structure foliated; lustre shining; electric by friction; scratches topaz: sp. gr. 3.8.

Fig. 125.



Fig. 125. A broad, short, four-sided prism, or table.

Fig. 126.



Fig. 126. A flat six-sided prism, so truncated as to appear as an eight-sided prism terminated by six-sided pyramids.

\* A superior kind of beryl.

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What is said of pycnite?—What is the colour and form of chrysoberyl?

*Chemical characters.* Infusible alone; with borax, in small particles melts into a yellowish green transparent glass, which becomes colourless on cooling.

*Composition.* Alumine 71.5; silice 18; lime 6; oxide of iron 1.5.—*Klaproth.*

*Distinctive characters.* The beryl is infusible with borax; the emerald with borax melts into a colourless glass. Its great hardness being next to that of sapphire, will distinguish it from most minerals.

*Localities.* Ceylon and Brazil, where it is found in alluvial soils with the topaz, ruby, and sapphire.

U. S. Haddam, Conn. where it occurs chiefly in tabular crystals, of a yellowish green colour, embedded in granite with garnet, beryl, and talc.

*Use.* It is sometimes cut and polished for jewelry. It takes a high polish, but its colour is seldom of that rich and pleasant green exhibited by the emerald.

*Species 58. SPINELLE.*

*External characters.* Colour, red, often with tints of violet, yellow, or crimson, also dark brown, or black; occurs in round and angular grains, and crystallized in octohedrons, variously modified; translucent, transparent, or nearly opaque; structure lamellar; fracture conchoidal; lustre vitreous; scratches quartz: sp. gr. 3.7.

Fig. 127.

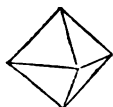


Fig. 128.

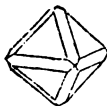


Fig. 127. The regular octohedron.

Fig. 128. The same with edges truncated.

*Chemical characters.* Infusible, and retains its colour, even when melted by the compound blow pipe.

*Composition.* Alumine 84.47; magnesia 8.78; chromic acid 6.18.—*Vauquelin.*

---

How is chrysoberyl known from beryl, emerald, and other minerals?—Where has this mineral been found in this country?—What is the colour and what the crystalline forms of spinelle?—What is its composition?



The colour is probably owing to the chromic acid.

*Distinctive characters.* It resembles the precious garnet, but the garnet is fusible; it also resembles some varieties of the zircon, but these lose their colour by heat. The red sapphire is harder and of a more lively red than spinelle. It may resemble octohedral iron, but this is magnetic.

It is found with sapphire and zircon, in the sand of rivers. Its geological situation is little known.

The scarlet coloured is termed *spinelle ruby*; the rose red, the *balas ruby*; the orange red, *rubicelle*, and the violet coloured, *almandine ruby*.—*Phillips*.

*Localities.* Ceylon, Mysore, and Pegu.

U. S. Boxborough, Mass. colours, bluish grey, and dark green.—*Robinson*. Warwick, N. Y. At this locality, Dr. Fowler, of Franklin, has discovered red and black spinelles of enormous and unprecedented sizes. The red is of various shades, inclining to brown, and the largest crystals, (octohedrons,) are nearly 4 inches in circumference. The black crystals are still larger; the largest measures 16 inches around the base, and many others give a base of 4 and 8 inches.

Both kinds are embedded in pink carbonate of lime, associated with crystals of serpentine.—*Silliman's Journal*.

#### Variety 1. PLEONASTE.

*External characters.* Colour, dark blue, or greenish black; occurs in octohedral crystals, and in rounded grains; structure indistinctly foliated; cross fracture conchoidal; scratches quartz; feebly translucent; transmits, in thin pieces, a dark, bluish, or greenish light: sp. gr. 3.8.

*Chemical characters.* Suffers no change alone; with borax melts into a dark green glass.

*Composition.* Alumine 72.25; silex 5.48; magnesia 14.63; oxide of iron 4.26.—*Berzelius*.

*Distinctive characters.* It is not so hard as spinelle.

*Localities.* Ceylon, in alluvial soils. Vesuvius and Somma, in the cavities of volcanic rocks.

#### Species 59. IOLITE.\*

*External characters.* Colour, violet blue, or purple, sometimes with a tinge of black; by transmitted light, in one direction, brownish yellow, in another, indigo blue; occurs massive, and in regular six and twelve-sided prisms; clea-

\* From the Greek, a violet, or purple stone.

Does it occur in this country?—What does the name iolite signify?

vage parallel to the sides of a six-sided prism ; lustre, shining vitreous ; fracture imperfectly conchoidal, or uneven ; translucent or opaque ; structure foliated ; scratches glass, and sometimes quartz : sp. gr. 2.56.

*Chemical characters.* Fusible on the edges ; with borax dissolves slowly into a diaphanous glass.

*Composition.* Silica 42.6 ; alumina 34.4 ; lime 1.7 ; magnesia 5.8 ; oxide of iron 1.5 ; oxide of manganese 1.7.—*Gmelin.*

*Localities.* Cape de Gatte and Grenada, in Spain, in a blue clay. Tunaberg, in Sweden, with pyritous copper. Greenland, embedded in quartz, or felspar. Siberia and Ceylon, in rolled masses.

#### *Variety 1. PELIOM.\**

*External characters.* Colour, blue ; occurs in six-sided crystals, truncated on the angles ; fracture conchoidal ; resembles the iolite in every respect except in colour.

*Locality.* Bodemnaïs, in Bavaria, in grey granite.

#### *Variety 2. STEINHEILITE.†*

*External characters.* Colour, light blue, sometimes with a tinge of red ; rarely colourless ; translucent ; occurs amorphous ; lustre shining ; fracture conchoidal : sp. gr. 2.69.

*Composition.* Silica 49.95 ; alumina 32.28 ; magnesia 10.45 ; oxide of iron 5.—*Von Bonsdorff.*

*Locality.* Finbo, in Finland, mixed with pyrites.

#### *Species 60. LAZULITE. AZURITE.*

*External characters.* Colour, fine azure blue ; occurs in crystals ; form, the oblique four-sided prism, and the six-sided prism ; also, and more commonly, in grains and small masses of the size of a hazlenut ; structure foliated ; translucent ; scratches glass ; lustre vitreous and shining ; brittle.

*Chemical characters.* Infusible alone ; with borax forms a yellowish glass.

*Composition.* Alumina 66 ; silica 10 ; lime 2 ; magnesia 18 ; oxide of iron 2.5.—*Tromsdorf.*

*Distinctive characters.* It resembles lapis lazuli and the azure carbonate of copper. But the lazulite is never impregnated with iron pyrites, and the lapis rarely occurs in crystals.

\* Signifying blue colour.

† After Count Steinheil.

---

Where is iolite found ?—What are the varieties of iolite ?—What is the colour of lazulite ?—How is lazulite distinguished from lapis lazuli, and azure carbonate of copper ?

The carbonate of copper is heavier, blackens under the blow pipe, and tinges borax green.

The lazulite does not afford the *ultra-marine*.

*Localities.* Stiria, in quartz, and Saltzburg, in clay slate.

*Species 61. CHRYSOLITE.*

*External characters.* Colours, green, yellowish green, and brownish green; occurs in angular rounded crystalline grains; primary form, a right prism, with rectangular bases; secondary form, eight, ten, or twelve-sided prisms, with truncated pyramidal terminations; the number of terminal faces varies from six to ten; sometimes the termination is wedge-shaped, with truncated edges; fracture conchoidal; lustre, splendid and vitreous; translucent or transparent; crystals often compressed with the broad lateral planes striated; scratches glass: sp. gr. 3.4.

Fig. 129.

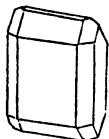


Fig. 129. A ten-sided prism, with two broad faces, terminated by two principal planes, corresponding with the lateral planes.

*Chemical characters.* Infusible alone, but turns brown; fusible with borax into a greenish transparent glass.

*Composition.* Magnesia, 50.5; silice 38; oxide of iron 9.5.—*Vauquelin.*

*Localities.* Hungary, in serpentine. In the isle of Bourbon, among volcanic products.

The chrysolite of commerce comes from the Levant.

The chrysolite was the tenth stone in the Jewish high priest's pectoral, bearing the name of *Zebulon*.

The Hebrew word commonly translated *chrysolite*, has also been rendered *carbuncle* and *beryl*.—*Calmet.*

*Uses.* Chrysolite is sometimes employed in jewelry, but is little esteemed on account of its softness.

*Variety 1. OLIVINE.\**

*External characters.* Colour, olive green; occurs in masses of various sizes, from grains to many pounds in weight; translucent; lustre shining, often metallic and iridescent

\* From its colour.

---

What is the prevailing colour of chrysolite?—Was this stone known to the ancients?—What is olivine?

from decomposition; fracture small conchoidal; structure somewhat foliated; brittle: sp. gr. about 3.24.

*Chemical characters.* Becomes brown, but does not melt; with borax fuses slowly into a yellowish green, translucent glass. Loses its colour in nitric acid.

*Composition.* Silex 50; magnesia 38.5; lime 0.25; oxide of iron 12.—*Klaproth.*

*Distinctive characters.* Its metallic lustre, foliated structure, and deeper coloured glass when melted with borax will distinguish it from chrysolite, and its localities from the other minerals which it resembles.

*Localities.* Bohemia, in basalt. Isle of Bourbon, in lava, and in most volcanic products. It is also occasionally found in trap and greenstone porphyry.

Olivine is said also to have been found by professor Pallas, in the meteoric iron of Siberia.

*Species 62. BRUCITE.\*—Gibbs.*

*External characters.* Colour, wine or amber yellow, or yellowish brown; occurs in grains and crystalline masses; also in four-sided prisms, with rhombic bases; lustre a little pearly; structure not apparent, or indistinctly foliated in one direction; crystals generally imperfect, sometimes terminated with dihedral summits; fracture uneven; hardness equal to that of felspar; translucent: sp. gr. 3.2.

*Chemical characters.* Infusible alone, but becomes white; with borax fuses slowly into a transparent globule, tinged with iron.

*Composition.* (From Pargas.) Magnesia 54; silex 38; oxide of iron 5.1; alumine 1.5; potash 0.86; manganese a trace.—*D'Ohsson.*

(That of Sparta.) Magnesia 54.000; silex 32.666; fluoric acid 4.086; potash 2.108; peroxide of iron 2.333; water 1.000.—*Seybert.*

*Localities.* Sudermannland, in Sweden.

U. S. Sparta, N. J. in foliated limestone, where it was discovered by Dr. Langstaff. Warwick, Orange county, N. Y.

*Species 63. HYDRATE OF MAGNESIA.*

*External characters.* Colour, white, often tinged with

\* In honor of Prof. Bruce, of New-York.

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Where is olivine found?—What is the colour of brucite?—Whence does this mineral derive its name?—Where is brucite found in this country?

green; occurs in plates, or thin pieces; structure foliated; the folia often radiating from a centre; lustre shining and pearly; somewhat elastic; translucent, in thin plates transparent; soft; yields to the nail; adheres slightly to the tongue; dissolves entirely, without effervescence in acids: sp. gr. 2.13.

*Composition.* Magnesia 70; water 30.—*Bruce.*

*Localities.* U. S. Hoboken, N. Y. in veins, from a few lines, to two inches in thickness, in serpentine. Also in Umanak, one of the Shetland Islands, traversing serpentine in all directions.

#### *Species 64. SERPENTINE.\**

*External characters.* Colours, green, yellowish, brown, or blackish green; also, reddish and greyish; colours often run into spots, stripes, or veins; occurs massive, and very rarely in rhombic crystals; fracture splintery, uneven, conchoidal; translucent or opaque; receives a high polish; unctuous to the touch; yields to the knife: sp. gr. 2.5.

Serpentine, in rhomboidal crystals, has been discovered by Samuel Fowler, M. D. in Warwick, Orange county, N. Y. It occurs in crystalline carbonate of lime, with *spinelle*, *scapolite*, and *brucite*.—*Silliman's Journal.*

Warwick is probably one of the richest mineral localities in this, or any other country.

*Chemical characters.* Infusible alone, but turns white; with borax slowly dissolves with bubbling into a transparent greenish glass.

#### *Variety 1. PRECIOUS SERPENTINE.*

*External characters.* Colours, green, yellowish, or blackish green, or brown, often clouded; occurs massive; fracture conchoidal; translucent; fragments sharp edged; lustre glimmering; unctuous to the touch; yields to the knife; texture compact: sp. gr. 2.2.

*Composition.* Silica 32; magnesia 37.24; alumina 0.5; lime 10.2; oxide of iron 6; water 14.—*Hisinger.*

*Distinctive characters.* It is softer and more easily broken than nephrite, or jade, which it most resembles.

It is found in masses and beds in primitive limestone, gneiss, and mica slate.

\* From its resemblance to the skin of a serpent.

What is the composition of hydrate of magnesia?—What are the colours of serpentine?—Does it ever occur in crystals?—What minerals does precious serpentine most resemble?

**Localities.** Sweden, Bohemia, Saxony, Cornwall. In Italy it is intermixed with limestone, forming the *verd antique*.

U. S. Milford, Conn. It is embedded in primitive limestone, in irregular masses commonly enveloped in amianthus, and containing chromate of iron. Its colour is a rich green, and it receives a high polish. Near Newburyport, Mass. The precious serpentine of this place is often extremely beautiful, and perfectly resembles that of Kevens, in Cornwall.—*Dewey*. Phillipstown, N. Y. associated with white augite.—*Barry*.

*Variety 2.* COMMON SERPENTINE.

**External characters.** Colours, green, yellowish green, blackish green, brown, bluish grey, or reddish; colours variously intermixed, or running in stripes or veins; opaque or feebly translucent on the edges; occurs massive; fracture uneven, or splintery; harder than precious serpentine; scarcely yielding to the knife; often gives out the odour of clay, when breathed on: sp. gr. 2.5.

**Composition.** Magnesia 44; silex 44; alumine 2; oxide of iron 7.3; oxide of manganese 1.5; oxide of chrome 2.—*Vauquelin*.

It is found in primitive mountains, and according to Werner, in more recent formations overlaying the older primitive rocks.

It occurs with, and commonly embraces the precious serpentine.

**Localities.** Portsoy, in Scotland. Shetland Isles, Hebrides, Cornwall, &c.

U. S. Bare Hills, near Baltimore, Md. West Chester, and Montgomery county, Penn. Hoboken and Compton Plains, N. J. Rye, N. Y. Newport, R. I. Grafton, Ver.

At mount Roso, serpentine is found at an elevation of from 7 to 9,000 feet.

The whole front of the Alps which looks towards Italy, every where affords serpentine.

France, has some mountains of this mineral, particularly in Limousin.

The finest serpentine is said to occur near Grenada, in Spain, superb columns of which decorate the churches, and palaces of Madrid.

The mountain, called *Red Horn*, near Mount Rosa, is ele-

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In what city are columns of serpentine to be seen?

vated upwards of 7,000 feet, and is composed of compact serpentine, divided into irregular masses of immense size.

The serpentine of Bareith, is spotted with garnets of the size of a pea, the base being green. Ornaments are made of this, presenting fine red spots, contrasted with a deep rich green ground.

Saussure, found on the shores of the lake of Geneva, a variety of serpentine of remarkable specific gravity, it being 3.00.—*See Pinkerton.*

*Uses.* Jameson says, that at Zobnitz, in Upper Saxony, several hundred persons are employed in quarrying, cutting, turning and polishing the serpentine, which occurs in the neighbourhood, and that the various articles into which it is manufactured, are carried all over Germany.

*Species 65. ZIRCON.*

*External characters.* Colours, grey, green, yellowish, red, bluish, brown, and reddish; occurs in rounded grains or fragments; also crystallized, in the form of four-sided prisms, terminated by four-sided pyramids, and in dodecahedrons, composed of four hexagonal lateral faces, and of four rhomboidal terminal ones at each extremity; cleavage in two directions parallel to the axis of the crystal; structure indistinctly foliated; harder than quartz; translucent or transparent; lustre resinous, or adamantine: sp. gr. 4.4.

Fig. 130.



Fig. 130. A four-sided prism, terminated by four-sided pyramids. This is the common form.

*Chemical characters.* It is infusible, but loses its colour; with borax it forms a transparent glass.

*Composition.* Zirconia 69; silice 26.5; oxide of iron 0.5.—*Klaproth.*

*Distinctive characters.* It is not so hard as chrysoberyl. It is more transparent than staurotide. Idocrase, which it resembles, is fusible alone, and from these and all other stones which it resembles, it may be known from its greater specific gravity, hardness, and peculiar oily lustre when cut and polished.

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What use is made of this mineral in Upper Saxony?—What are the colours of zircon?—What is the most common crystalline form of zircon?

It occurs in the beds of rivers and alluvial soils, with *epidote*, *tourmaline*, &c. also embedded.

*Localities.* Ceylon, in the sand of rivers, and embedded in crystalline slate. Norway, in *sienite*. Galloway, in Scotland, and Auvergne in France.

U. S. Buncombe County, N. C. in four-sided prisms, terminated by four-sided pyramids. On the Schuylkill, 14 miles from Philadelphia, Penn. in small light brownish crystals.—*Jessup*. Near Trenton, N. J. Also at Franklin Furnace. At Schooley's Mountain, N. Y. Sharon, Conn. Colour, dark brown, crystals seldom exceed half an inch in length.—*Silliman*. Two miles from Baltimore, Md. Philipstown, N. Y. East Marlborough, Penn. in beautiful tetrahedral prisms; colour, brownish red.—*Carpenter and Spackman*.

*Uses.* It is cut and set as a precious stone. Jameson says it exhibits in a faint degree the play of colours belonging to the diamond, and that it is frequently sold as an inferior kind of diamond. The pale variety is used in the jewelling of watches instead of the diamond.

#### Variety 1. HYACINTH.

*External characters.* Colour, various shades of red, as yellowish or brownish red; occurs in small angular, or rolled grains, and in crystals; form the four-sided prism, terminated by four planes, which are set on the lateral edges; crystals short, small, and often variously terminated; lustre vitreous, inclining to resinous; structure foliated; transparent or translucent; fracture conchoidal; cleavage parallel to the sides of the primitive octohedron: sp. gr. 4 to 4.6.

*Chemical characters.* Infusible, loses its colour but retains its transparency. With borax fuses into a colourless glass.

*Composition.* Zirconia 70; siliceous 25; oxide of iron 0.5.—*Klaproth*.

It occurs in primitive rocks, and is found in the beds of rivers.

*Localities.* Ceylon. Near Pisa, in Italy. Auvergne, in France, in volcanic sand. Lisbon, Saxony, and in Fifeshire, in Scotland.

The *oriental hyacinth* is an orange coloured sapphire. The *occidental hyacinth* is a topaz. The *volcanic hyacinth* is the *idocrase*, or *vesuvian*.

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In what countries is zircon found?—What are the localities of zircon in this country?—What are the uses of zircon?—What are the colours of hyacinth?



The hyacinth is frequently mentioned by the sacred writers. St. John says that the eleventh foundation of the heavenly city is a hyacinth, and in Canticles, gold rings, set with hyacinths, are spoken of. Moses often speaks of the hyacinth colour, which learned interpreters say meant, violet colour, or azure blue tinged with red. Hyacinth colour now means yellowish red, so that it is at present uncertain what stone the ancients meant by the hyacinth, most probably, however, it was the amethyst.

*Uses.* When of a good colour, and without flaws, it is much valued in jewelry. It is said, that, after destroying the colour by heat, it is sometimes sold for the diamond.

*Variety 2. JARGOON.*

*External characters.* Colours, greenish, bluish grey, and brownish red, always faint and passing into colourless; occurs in small four-sided prisms, and in grains; lustre splendid and adamantine; transparent or translucent: sp. gr. 4.4.

*Chemical characters.* Becomes limpid by heat, but is infusible.

*Composition.* Zircon 66; silice 31; oxide of iron 2.—*Vauquelin.*

*Localities.* Ceylon, in the sands of rivers. Italy, Spain, and several parts of India.

*Uses.* It is employed in jewelry, particularly in ornamenting watch cases, and is said to be frequently sold in Paris for the real diamond. Indeed after the colourless variety is cut and set, it is difficult to distinguish it from diamond. It is considered the most valuable of the varieties of zircon.

*Species 66. EUCLASE.\**

*External characters.* Colour, light green of various shades, greenish white, bluish green, or sky-blue: occurs in crystals, in the form of oblique angled, four-sided prisms, variously modified and terminated; structure laminated; cleavage parallel to the sides of the prism: lustre strongly vitreous; cross fracture conchoidal; scratches quartz; very brittle; translucent or transparent: sp. gr. 2.91 to 3.32. Crystals longitudinally striated.

*Chemical characters.* Fusible into a white enamel.

\* From the Greek, signifying easily broken, in allusion to its brittleness.

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What do the scriptures say of the hyacinth?—What is the use of hyacinth?—What is its composition?—What is said of jargon?—What is the prevailing colour of euclase?

**Composition.** Glucine 21.78 ; silic 43.32 ; alumine 30.54 ; iron 2.22 ; oxide of tin 0.70.—*Berzelius*.

**Distinctive characters.** Its fusibility and brittleness will distinguish it from the greenish varieties of zircon ; idocrase melts into a yellowish glass. The different forms of its crystals will distinguish it from emerald and beryl.

**Localities.** Peru and Brazil. Its localities and associations are unknown.

Jameson observes, that it is a beautiful fossil, but cannot be employed in jewelry on account of its brittleness.

Phillips has given the figure of a crystal of euclase, which exhibits 78 longitudinal faces. The faces are so narrow as to make it appear striated.

#### *Species 67. BERYL.*

**External characters.** Colours, green, yellowish green, bluish green, or greenish white, always pale ; occurs in six-sided crystals, terminated by six-sided pyramids ; crystals often taper gradually, from one end to the other, and are of all sizes, from a line to a foot in diameter ; lateral faces striated, often so deeply as to render the angles indistinct ; large crystals frequently contain other substances, or are hollow in the line of the axis ; transparent or translucent ; lustre vitreous ; scratches quartz ; fracture uneven or conchoidal : sp. gr. 2.67.

**Chemical characters.** Infusible, but turns white and turbid. With borax, it fuses into a nearly transparent glass.

**Composition.** Silic 68 ; alumine 15 ; glucine 14 ; lime 2 ; oxide of iron 1.—*Vauquelin*.

**Distinctive characters.** It differs from the emerald in being of a paler green ; apatite is much softer and dissolves in nitric acid, it also phosphoresces on hot coals. The greenish variety of tourmaline resembles the beryl, but is softer, electric by heat, and fusible alone.

Beryl belongs to primitive rocks, and particularly to that variety of granite called graphitic. It is associated with garnets, quartz, chrysoberyl, schorl, topaz, &c.

**Localities.** Siberia, Persia, on the confines of China. Limoges, in France, Aberdeen, in Scotland. Peru, Brazil, Saxony, and Elba.

U. S. Haddam, Brooklyn, Litchfield, Chatham, and Middle Haddam, Conn. Crystals 7 or 8 inches long have been found

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What is the composition of euclase ?—What is the colour of beryl ?  
How does beryl differ from emerald ?—Is beryl a common or mineral ?

at Haddam. One in the cabinet of Yale College is 7 inches long, and 9 in the diagonal diameter.—*Silliman*. Germantown, Chesnut Hill, East Marlborough, and in Chester County, Penn. Chesterfield, Goshen, and in the vicinity of Boston and Northampton, Mass. At Goshen, two rose-coloured emeralds have been found, one of which is an inch and a half long.—*Gibbs*. In the state of Maine, it is found more or less constantly to an extent of 30 miles in the counties of Lincoln and Cumberland, also at Topsham and Bowdoinham.—*Cleveland*. Cumberland, R. I.

*Uses*. Beryl is occasionally employed in jewelry, but its pale colour and numerous fissures commonly render it unfit for this purpose. The greenish variety is set with a steel coloured, or greenish blue foil. The pale or nearly limpid variety is set on a black ground like the diamond, or on a silvery foil.

The beryl is mentioned in Scripture as the eighth stone in the high priest's pectoral, or according to Calmet, the twelfth, with the name of *Naphthali*, engraved on it. According to some learned writers, our beryl is the same with that meant in scripture.

The only remarkable differences between the *emerald* and *beryl* are in their colours, which, however, produces such an uninterrupted series, that only arbitrary limits can be fixed within it. The colour of emerald, is emerald green; all the varieties of other colours are beryl.—*Mohs*.

*Species 68.*—EMERALD.

*External characters*. Colours, lively emerald green, or bluish green, always rich and beautiful; occurs in long six-sided prisms, generally perfect, and variously terminated; structure imperfectly foliated; not so large as beryl; scratches quartz; lustre vitreous and shining; becomes electric by friction; crystals seldom more than two or three inches long; transparent or translucent: sp. gr. from 2.60 to 2.77.

Fig. 131.

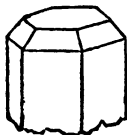


Fig 131. A six-sided prism, acuminated by six planes corresponding with the lateral planes.

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Is our beryl the same as that mentioned in scripture?—What is said of the green colour of the emerald?

Fig. 132.

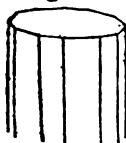


Fig. 132. A six-sided prism, with truncated lateral planes.

Fig. 133.



Fig. 133. A six-sided prism, terminated by a six-sided pyramid, the planes of which are set on the angles of the prism, with the angles of the summit truncated.

*Chemical characters.* Fusible with difficulty into a porous glass. With borax slowly dissolves into limpid glass.

*Composition.* Silica 64.5; glucine 13; alumina 16; lime 1.6; oxide of chrome 3.25.—*Vauquelin*.

*Distinctive characters.* It is known from beryl by its deeper and richer green, and from green tourmaline by the same quality. From apatite by its greater hardness and insolubility in acids, and from chrysoberyl, by being less hard, more transparent, and of a brighter green.

The emerald has been found chiefly in secondary countries, but it is supposed that its proper situation is in primitive rocks.

*Localities.* The finest emeralds formerly came from Manta, in Peru, but it is said that this mine is exhausted, and that the best are now found in the valley of Tunca, in Santa Fe, where they occur in granite.

The emerald was well known to the ancients, and was the third stone, according to Calmet's arrangement, on the high priest's breast-plate of judgment, with the name of *Zebulon* inscribed on it.

In the time of Pliny, this stone was held in so high estimation, that it was seldom or never engraved upon, which probably is the reason, that scarcely any well authenticated antique engravings exist on this gem. The moderns have, however, engraved upon it, as there exists, in the royal collection at Paris, a head of Henry IV. and another of Lewis XIV. on the emerald.

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What are the crystalline forms of the emerald?—Whence do the finest emeralds come?

An emerald is said to have existed at the Chapel of our Lady, at Loretto, in Italy, larger than a man's head, and for which an English gentleman offered 90,000 crowns.

Keysler, in his travels, has given the outline of an emerald, which he saw at the monastery of Reichenau, in Switzerland, and which was presented by Charles the Fat. This emerald, says he, weighs 28lb. 3qrs., and could be sold for £6,550 sterling per pound.

Later authors, however, say that this is *green fluor*, or *green glass*.

Probably the largest real emerald ever found, was that possessed by the inhabitants of the valley of Manta, in Peru, which according to De la Vega, was about the size of an ostrich's egg. When the Spaniards arrived there, it was worshipped, as the goddess, or mother of emeralds, and smaller ones were brought to it as offerings.

But perhaps the most magnificent specimen of genuine emeralds in the world, was presented to the cathedral of Loretto, by one of the Spanish kings. It consists of a mass of white quartz, thickly implanted with emeralds more than an inch in diameter.

According to Mohs, the locality where the ancients procured their emeralds, had been lost until within a few years, but has been re-discovered in Mount Zalara, Upper Egypt, in granite and mica-slate.

*Uses.* Emeralds are cut and polished for the most expensive kind of jewelry. Those of the first quality require no foil, but are set on a black ground like the diamond; inferior ones are set with a green gold foil, or on green satin.

*Species 69. GADOLINITE.\**

*External characters.* Colours, greenish, or brownish black; occurs massive, and rarely in crystals which are ten-sided prisms; lustre splendent, or shining resinous; slightly translucent; scratches glass; fracture conchoidal: sp. gr. 4.20.

*Chemical characters.* Before the blowpipe it intumesces and throws out cauliflower-like ramifications.—*Phillips*.

Mohs says it decrepitates, but does not melt except in small splinters.

Cleveland says that it becomes red, as if burning. In nitric acid it loses its colour, and is converted into a jelly.

\* After Gadolin, who first found it.

What is the use of the emerald?—Is the emerald a valuable gem?

**Composition.** Ittria 54.75; silic 21.25; glucine 5.5; alumine 0.5; oxide of iron 17.5; water 5; magnesia, a trace.—

**Klaproth.**

**Localities.** Sweden, in several places.

The new earth *ittria*, was first discovered in this mineral by Dr. Gadolin.

U. S. Bolton, Mass.—*Webster.*

### CLASS III.

#### ACIDIFEROUS ALKALINE MINERALS.

This Class includes such minerals as consist chiefly of an alkali, united with an acid. Some of the species contain foreign matter, rendering them very impure. This division includes but a few articles.

#### Genus 1. POTASH.

This genus contains only one species.

#### *Species* 1. NITRATE OF POTASH. NITRE.

The well known salt, nitre, or saltpetre, often occurs native, in greater or less quantities. It is found in capillary crystals, and crusts, of a saline cooling taste; transparent or translucent; deflagrates when thrown on burning charcoal, and dissolves in water.

It is particularly found on old walls, and in the earth, and decayed substances of ancient buildings. It is also found in some calcareous countries, and in ancient situations, once inhabited, but now lying waste.

**Localities.** Several plains in Spain; on the chalk formations in some parts of France, in the grottoes of Mount Hamberg, in Germany. In Hungary, Arabia, Italy, Persia, and other countries.

In many of these countries, nitre is extracted from the earth in particular places by lixiviation, and after being purified and crystallized, is fitted for commerce.

U. S. Rackoon Mountain, Geo. Abundant in a cavern, the earth of which contains from 3 to 10 lbs. of salts to the bushel. It is partly nitrate of lime, which is decomposed by wood ashes.—*Cornelius.* Madison County, Ken. in a cave 646 yards long, and about 40 feet broad. The earth contains

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What is the composition of gadolinite?—What are the minerals of the third class chiefly composed of?

both nitrate of potash, and nitrate of lime. It is lixiviated, and the nitrate of lime decomposed by wood ashes. Kentucky furnishes large quantities of nitre, from this and other localities.—*Cleveland*. In some parts of the state of Kentucky, it is said that masses of native nitre are found weighing several pounds.

Nitre is also obtained from earth found in sheltered places, in several parts of Ohio.—*Atwater*.

*Uses.* Its principal employment is in the manufacture of gun-powder, and the nitric acid. It is also used in the curing of meat ; for the purpose of obtaining oxygen for chemical experiments, for medicinal purposes, for fluxes, &c.

Potash is essentially composed of the metal *potassium* and oxygen.

### *Genus 2. SODA.*

Soda is found combined with carbonic, sulphuric, nitric, boracic, and muriatic acids, forming sulphate, carbonate, nitrate, borate, and muriate of soda.

#### *Species 1. CARBONATE OF SODA.*

*External characters.* Colours, greyish, or yellowish white ; occurs crystallized, massive, fibrous, encrusting, and efflorescent ; the massive is compact or granular ; the fibrous, often radiated ; lustre glistening ; translucent ; taste, urinous and saline.

*Chemical characters.* It effervesces with acids, and when dissolved in muriatic acid, forms *common salt* ; in sulphuric acid, forms *glauher's salt*.

*Composition.* (When pure,) soda 22 ; carbonic acid 15 ; water 62.

Soda is composed of the metal *sodium* and oxygen.

It is always impure in the natural state, being mixed with various portions of muriate, and sulphate of soda, or muriate of lime.

This salt is found in many parts of the world in crusts, on certain decomposing rocks, in lakes, on the surface of the soil, or in the waters of certain springs.

*Localities.* Bohemia, dissolved in the hot springs of Carlsbad. Egypt, in the Natron Lakes. These are six in number, situated in a barren valley westward of the Delta. The edges

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What is the composition of nitrate of potash ?—What are the uses of nitrate of potash ?—What are the substances with which soda is found naturally combined ? What is the composition of common salt ?—What is the composition of pure soda ?

of these lakes in the hot and dry season, are surrounded by a band of white salt, several yards in breadth. It consists chiefly of natron, but is mixed with common salt. Hungary contains several lakes, which in winter are full of water, but in summer, when the water evaporates, saline efflorescences appear, consisting of natron with a little glauber's salt, and epsom salt. One crop being gathered, another appears in a few days, and this harvest continues until fall. Africa, between Tripoli and Fezzan, contains large quantities of the radiated variety, called *trona*. It lies in a thin stratum, in a bed of common salt. From this place it is said hundreds of tons are annually collected.

*Uses.* It is principally employed in the manufacture of soap and glass. It is also used in the Levant to give a sharper taste to smoking tobacco, by mixing a little with it. The ancient Egyptians are said to have made use of *natron*, in preparing the bodies of their dead for mummies.

*Species 2.* SULPHATE OF SODA. GLAUBER SALT.

*External characters.* Colours, greyish, or yellowish white; occurs in efflorescences and in an earthy form, but is more commonly dissolved in certain mineral waters. When water containing it, is evaporated, it yields prismatic crystals with dihedral summits; when exposed to the air, they soon effloresce, or lose their water of crystallization, and fall into a white powder. It rarely if ever is found in native crystals; taste saline and nauseously bitter.

*Composition.* (When pure.) Soda 15; sulphuric acid 27; water 58.

It is found in many mineral waters, generally with other salts, as epsom and common salt, and, perhaps, is the result of the mutual decomposition of these two salts.

*Localities.* It is found in the lakes of Austria, Lower Hungary, Siberia, and Russia. Near Madrid, it is said to occur in efflorescences at the bottom of a ravine. Indeed, small quantities of it are found in most countries.

The glauber's salt, generally used in medicine, is prepared from *bittern*, the liquor which remains after the extraction of common salt from sea-water.

*Species 3.* NITRATE OF SODA.

This salt is described by Mariano de Rivero, in the Ann.

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What are the uses of the carbonate of soda?—What is the composition of glauber's salt?—How is the glauber's salt used in medicine obtained?



des Mines, for 1821, p. 596, as occurring in immense quantities in the district of Tarapaca, in Peru, near the frontiers of Chili, and three days' journey from La Concepcion. It there forms a bed several feet thick, which in many places appears on the surface, and occupies an extent of more than forty leagues. The salt appears occasionally as an efflorescence, sometimes crystallized, but more often mixed with clay or sand ; to the taste it is cool and bitter ; it is deliquescent, and when exposed to heat, it behaves like nitrate of potash ; it contains a little sulphate of soda. Very large quantities of this salt, purified by solution and crystallization, have already been imported into Europe.—*Phillips*.

*Species 4. BORATE OF SODA. BORAX.*

*External characters.* Colour, white, sometimes with a tinge of blue or green ; occurs in prismatic crystals, variously terminated, and yielding to cleavage parallel to the sides of the primitive form, which is an oblique rhombic prism ; translucent or transparent ; sometimes opaque.

*Chemical characters.* Intumesces largely, gives somewhat of a crackling noise, and fuses into a transparent globule, which is unalterable by the heat of the blowpipe.

*Composition.* Soda 17 ; boracic acid 36 ; water 47.—*Berzelius*.

This salt is supposed to have been known to the ancients, and to be the substance called *crysocola*, by Pliny. It is brought from the East Indies, in an impure state, and in commerce is denominated *tincal*. After being purified, which is done by the Dutch and British, it is called *borax*.—*Thompson*.

Tincal is brought chiefly, if not only, from Thibet, where it is procured from a lake which is entirely supplied by springs. The edges and shallows of the lake are covered with a stratum of borax, which is dug up in considerable masses, and the holes thus made, are gradually filled by a fresh deposition.—*Phillips*.

It is said also to be met with in Ceylon, and in considerable quantity in Potosi.—*Mohs*.

*Uses.* Borax is made use of as a flux, and is especially useful in testing mineralogical specimens, and particularly ores. It enters into the composition of artificial gems, and is used in soldering, and in medicine.

The purification of tincal is an art confined to a few chemists, and the process is kept a secret.

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What is the composition of borax ?—Whence does borax come, and what is the mode of obtaining it ?—What are the uses of borax ?

*Species 5. MURIATE OF SODA. COMMON SALT.*

Pure rock salt is so universally known as to require no description. Its primitive form is a cube, and into this it may readily be cleaved; structure lamellar; translucent or transparent.

*Chemical characters.* It decrepitates violently, but, between two pieces of charcoal, may be fused; when it tinges the flame yellow, diffuses itself over the surface of the charcoal, and sinks into its substance. Heat does not increase its solubility in water.

*Composition.* Soda 53.44; muriatic acid 46.55.—*Berzelius.*

In its impure state, as it is commonly raised from the mine, rock salt is in large and solid masses of a crystalline structure, and of a reddish or bluish colour; translucent, presenting impurities to the eye in spots, or veins.

It is almost always associated with gypsum, which either lies above, or below it, or both, or is intermixed with it. Sometimes the gypsum is so impregnated with the salt, as to be worth working on that account.

Common salt is one of the most abundant productions of nature. Besides the immense beds of it which are known to exist in different parts of the world, together with inland springs, which contain it in large quantities, the ocean contains about a thirtieth part by weight, of common salt, and may be considered its greatest repository.

*Localities.* Spain, contains vast quantities of rock salt. In Spanish Navarre, between Caparosa, and the river Ebro, is a hill of considerable elevation, and about four hundred paces long, by eighty wide, composed of rock salt, with interposing layers of gypsum.—*Bowles.*

But a much more remarkable deposit of the same kind exists at Cordova, sixteen miles from Barcelona, in Spain. This is a mountain of massive rock salt, about four or five hundred feet high, and a league in circumference. It is without chasms, crevices, or layers. The colour of this salt is white, sometimes red or blue.—*Bowles.*

Ulloa mentions the vast deposites of rock salt which exist in Peru, and says the mountains of salt are equally as high as those which yield silex and mercury. These mines of salt

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What is the composition of common salt?—What is the mineral with which common salt is chiefly associated?—What is said of the quantities in which common salt exists?

form a part of the grand chain of the Andes, and are situated ten or twelve thousand feet above the level of the sea.

In Siberia, there is said to be a mountain of rock salt, one hundred and eighty feet high, and one hundred and twenty feet in length.—*Pinkerton*.

Poland and Hungary afford immense quantities of common salt. The celebrated mines near Cracow, have been wrought since 1251. One of the shafts of this mine is more than a thousand feet deep.

In descending to the bottom, says Shaw, the visitor with surprise, finds a subterraneous commonwealth of families, who have their peculiar laws and polity. They have public roads, horses and carriages. These horses, when once immured in this destination, never more see the light of day, and many of the people are buried alive in this abyss, having been born there, without ever having made a journey to the surface of the earth. This subterranean community have several chapels hewn out of the rock salt, and many crucifixes and images of saints, before which lights are constantly burning.

Germany, Italy, Russia, Sweden, Norway, and almost every other country possess either mines of salt, or springs from which it is produced by evaporation.

England yearly exports great quantities of salt. From the springs in Worcestershire, 16,000 tons are annually produced; and 156,000 tons of rock salt are annually raised from the great deposit, near Norwich, in Cheshire.

U. S. The United States are well supplied with the means of manufacturing this indispensable article. Salt springs are numerous, and most of them situated far inland, thus preventing the necessity, in many instances, of transporting so heavy an article to any great distance by land.

Salt springs exist in Arkansas, Missouri, in several places at the head waters of the Ohio, in Virginia, Kentucky, Illinois, New-York, &c.

Near Shawneetown, Illinois, is a spring which yields annually 150,000 bushels of salt. It sells at 70 cents per bushel. *Schoolcraft*.

Near the Muskingum, in Ohio, is a salt spring, which furnishes 80 bushels of salt daily.—*Atwater*.

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In what countries are the most remarkable deposits of common salt?  
—What is said of the salt mines of Cracow?—Where are the salt springs of the United States?

The state of New-York furnishes more than 500,000 bushels of salt yearly.—*Gibbs*.

The whole quantity of salt annually extracted from saline springs in the United States, was several years ago estimated at one million of bushels.—*Cleveland*.

*Genus 3. AMMONIA.*

Ammonia, or *volatile alkali*, when pure, exists only in a gaseous form. It is composed of about 98.24 nitrogen, and 1.76 hydrogen. Sir Humphrey Davy, from his experiments, was led to suppose that its base was a metal, but this requires further proof.

It is found combined with the sulphuric and muriatic acids, forming sulphate, and muriate of ammonia.

*Species 1. SULPHATE OF AMMONIA.*

*External characters.* Colour, greyish or yellowish; occurs in stalactites and crusts; externally it is usually covered with a whitish dust; taste acrid and bitter.

*Composition.* Ammonia 40; sulphuric acid 42; water 18.—*Phillips*.

*Localities.* Sienna, in Tuscany, surrounding certain small lakes; also in the lavas of Etna and Vesuvius.

*Species 2. MURIATE OF AMMONIA.*

*External characters.* Colours, greyish white, white, yellow, green, and brownish black; occurs massive, with a fibrous structure, plumose, in crusts, and in angular crystals, of which the cube is the primary form; taste pungent and saline; externally dull; internally, shining and vitreous.

*Composition.* (That of Vesuvius.) Muriate of ammonia 99.5; muriate of soda 0.5.—*Klaproth*.

The crystals are small, and intersect each other.

Jameson, from Estner, enumerates the following forms, besides the cube under which it appears. Complete rhomboid. Rectangular four-sided prism, acuminate by four planes. Garnet dodecahedron, sometimes truncated on all the edges.

When rubbed with quicklime, it emits the odour of ammonia.

It is the product of volcanoes, or of art.

*Localities.* Etna, Solfatera, Vesuvius, Lipari, Hecla, and other volcanic countries.

The *sal ammoniac* of commerce was formerly brought from Egypt, but is now prepared in large quantities in several parts

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In what form does pure ammonia exist?—With what acids is ammonia found combined?

of Europe, and particularly at Paris. Different processes are employed in its manufacture. At Paris, two separate kilns are constructed, into one of which are put a mixture of common salt and sulphuric acid, and into the other animal matters, as parings of hides, horns, hoofs, &c. On the application of heat, muriatic acid gas is extricated from one kiln, and ammonia from the other. These two gases are conveyed in pipes to a chamber lined with lead, where they combine and form *muriate of ammonia*. In England, a process somewhat different is employed.

#### CLASS IV.

##### ACIDIFEROUS ALKALINO-EARTHY MINERALS.

The minerals arranged under this class, contain an alkali and an earth, acidified by the sulphuric, or fluoric acids, forming salts of different characters. The species are few in number, and some of them but little known.

##### *Species 1.* SULPHATE OF ALUMINE AND POTASH. ALUM.

*External characters.* Colours, white, yellowish, or greyish white; occurs in efflorescences on argillaceous minerals, chiefly on alum slate, or alum stone; also in crusts and stalactites, or massive, with a fibrous texture; taste, sweetish and astringent.

*Composition.* Alumine 15.25; oxide of iron 7.50; potash 0.25; sulphuric acid and water 77.—*Klaproth*.

(Artificial alum.) Alumine 10.50; potash 10.40; sulphuric acid 30.52; water 48.58.—*Vauquelin*.

Native alum is found in volcanic countries, but more commonly on alum slate, where it is formed by the combination of the alumine, potash, and sulphuric acid, which the stone contains.

*Localities.* Scotland, in the coal mines near Paisley. Bohemia, in many places on alum slate. In the vicinity of volcanoes, as Stromboli, Solfatera, Vesuvius, &c.

U. S. Catskill mountain, and twelve miles from Catskill, N. Y. Navesink hills, N. J. Several places in Ohio. Pownal, Vt. Leyden, Mass. Bolton, Conn.

*Mode of making alum.*—Ferber says, that the rocks which yield the Roman alum, are situated at Tolfa, in Italy. In colour, they are white, or whitish grey. They are con-  

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How is the ammonia of commerce prepared?—What are the minerals of the fourth class chiefly composed of?—What is the composition of alum?

ably elevated, and full of large excavations made by the workmen, who descend by ropes, and procure the kind proper for use, by blasting.

Having raised the alum stone to the surface of the earth, it is first calcined in a wood fire, and then, while hot, thrown into reservoirs of water, where it remains until the alum is extracted by the water. The liquor is then drawn off and boiled in brass pans, until it is in a proper state for the alum to crystallize, when it is removed into wooden coolers, and allowed to shoot into crystals. While boiling, a quantity of lime is mixed with the lixivium.

The alum rock contains sulphate of iron, alumine, and potash. The calcination converts the sulphur to sulphuric acid, which uniting to the alumine and potash, forms *sulphate of alumine and potash*, or *alum*. When the rock contains no alkali, a little is added, and for this purpose, wood ashes is commonly used.

U. S. At Cape Sable, Md. is a manufactory of alum. The ore consists of earthy lignite, mixed with pyrites. This is piled in heaps and suffered to remain in that state for about a year, when the sulphur is acidified by the action of the atmosphere. It is then lixiviated, and the liquor concentrated by boiling, when crystals of alum are formed.—*Cleveland's Mineralogy*.

#### *Species 2.* ALUM-STONE.

*External characters.* Colours, greyish white, brownish, or reddish; occurs massive and crystallized; form the obtuse rhomboid, variously modified by truncation, one or more of the solid angles being commonly replaced; crystals very minute, and generally found in the cavities of the massive; massive, translucent; yields to the knife; fracture conchoidal, splintery, or sometimes earthy: sp. gr. from 2.42 to 2.77.

*Chemical characters.* Decrepitates, emits a sulphureous gas, and afterwards absorbs moisture from the tongue, and gives the taste of alum; insoluble in water.

*Composition.* Alumine 43.92; silice 24; sulphuric acid 25; potash 3.08; water 4.—*Vauquelin*.

Prof. Mohs says, that on charcoal, by itself, it does not melt, but is fusible with borax into a colourless glass, and that when reduced to powder, it is soluble in sulphuric acid.

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What is the mode of making alum?—What are the chemical combinations by which alum is formed?—Where is alum manufactured in this country?—What is said of alum stone?

**Localities.** Tolfa, near Rome ; also in Tuscany, and Hungary, and in the vicinity of several burning mountains. According to Cordier, as quoted by Phillips, it exists in almost all burning mountains.

**Uses.** It is used in the manufacture of alum, and the superior quality of that produced at Tolfa, is ascribed to the employment of this mineral.—*Mohs.*

*Species 3.* ALKALINE FLUATE OF LIME.

**External characters.** Colours, white, greyish white, or brownish ; occurs massive ; structure perfectly lamellar, with joints parallel to all the planes of a rectangular prism ; translucent ; becomes transparent by immersion in water ; not so hard as fluor : sp. gr. 2.94.

**Chemical characters.** Fuses into a transparent globule, which becomes opaque on cooling.

**Composition.** Alumine 21 ; soda 32 ; fluoric acid and water 47.—*Vauquelin.*

**Localities.** West Greenland, in two small layers in gneiss, one of which contains the white variety, and the other those that are coloured.

*Species 4.* AMBLYGONITE.

**External characters.** Colours, greenish white, or sea green ; occurs in rhombic prisms, which are rough externally ; cleavage parallel to the sides of the prism ; lustre brilliant ; transparent, or translucent when in thin laminæ ; hardness equal to felspar : sp. gr. 3.00.

**Chemical characters.** Easily fusible, with intumescence into a white enamel.

**Composition.** Alumine, lithia, phosphoric, and fluoric acids.

Berzelius considers it as a double sub-phosphate of alumine and lithia, containing fluoric acid.

**Locality.** Near Penig, in Saxony, where it occurs in granite along with tourmaline and topaz.

*Species 5.* ANHYDROUS SULPHATE OF SODA AND LIME.

GLAUBERITE.

**External characters.** Colour, yellowish or greyish white ; occurs massive, and in the form of flat rhombic prisms ; lateral planes striated transversely ; the terminal ones smooth ; structure foliated ; lustre vitreous ; streak white ; semi-transparent ; yields to the knife : sp. gr. 2.7.

**Chemical characters.** Fusible with decrepitation, into a white enamel. If thrown into water it becomes opaque, and is

artly dissolved. The same happens if exposed to a moist atmosphere.

*Composition.* Sulphate of soda 51.0 ; sulphate of lime 49.

!—*Brongniart.*

*Localities.* Near Ocana, in New Castle, also in Upper Austria.

*Species 6. POLYHALLITE.\*—Stromeyer.*

*External characters.* Colour, brick red or colourless ; occurs in amorphous masses, partly compact and partly fibrous ; fibres, parallel or curved ; transparent or translucent ; the compact yields to cleavage parallel to all the planes of the cube ; brittle ; scratches calcareous spar : sp. gr. about 2.77.

*Chemical characters.* In the flame of a candle becomes an opaque mass of a brownish colour ; melts instantly before the blow pipe.

*Composition.* Sulphate of lime 28.25 ; anhydrous sulphate of lime 28.42 ; anhydrous sulphate of magnesia 20.03 ; sulphate of potash 27.70 ; muriate of soda 0.19 ; red oxide of iron 0.34.—*Stromeyer.*

*Localities.* Ischel, in Upper Austria ; also at Vic, in Lorraine ; in both places among rock salt.

## CLASS V.

### ALKALINO-EARTHY MINERALS.

The minerals belonging to this class, consist of earths in various proportions ; including generally, in their composition, one or more of the alkalies. Many of them also contain small quantities of the oxides of one or more metals, as iron, or manganese, from which they derive their colours ; but these are not considered essential ingredients.

*Species 1. MICA.†*

*External characters.* Colours, white, green, brown, black, red, yellowish, and bluish ; occurs crystallized, massive, and disseminated ; form, six-sided tables, and oblique rhombic prisms ; structure perfectly foliated ; lustre glittering, or somewhat metallic ; translucent ; the white variety in thin pieces, transparent ; easily separable into thin plates, which

\* From the Greek, signifying a stone of many salts ?

† Vulgarly called isinglass. Its name comes from the Latin, *mico*, to shine, or glitter.

What is the composition of glauberite ?—What are the properties of polyhallite ?—What are the minerals of the fifth class chiefly composed of ?—What are the colours of mica ?



are flexible and elastic to a high degree ; yields easily to the knife : sp. gr. about 2.7.

*Chemical characters.* Fusible into an enamel of different colours, depending on that of the mica.

*Composition.* (From Siberia.) Silica 48 ; alumina 34.25 ; potash 8.75 ; oxide of iron 4.5 ; of manganese 0.5 ; water 1.25.—*Klaproth.*

There is much difference in the composition of the several coloured varieties.

*Distinctive characters.* Talc, which it most resembles, is unctuous to the touch, and inelastic. Foliated gypsum, which it also resembles, is inelastic, and in the heat of a candle, instantly turns white and opaque. Cyanite is harder, inelastic, and infusible.

#### *Variety 1. PLUMOSE MICA.*

The most common colour is greyish white, but it may assume any of the colours of the species. It occurs in fine delicate crystals, diverging from a central line, so as to imitate the feathers of a quill, or plume, whence the name.

#### *Variety 2. LAMINATED MICA.*

It occurs in large plates, which according to Hauy, are sometimes found in Russia, a yard in extent. It is easily separated into thin shining laminae.

Mica, although it does not form beds alone, is a very abundant mineral, being universally distributed among primitive rocks, and forming an essential ingredient in granite, gneiss, and mica slate.

Hence its localities are in every primitive country, and only a few, where fine specimens occur will be mentioned.

*Localities.* U. S. Germantown, Penn. in six-sided tables, and prisms.—*Wister.* In the Highlands, at Muncie iron works, N. Y. in black six-sided tables, six inches in diameter.—*Pierce.* Woodbury, Conn. violet coloured ; also at Watertown, occurs the plumose variety, and near Hartford, in small crystalline masses resembling the garnet. Bellows Falls, Ver. rose coloured.—*Silliman.* Brunswick, Maine, of a beautiful green.—*Cleveland.*

*Uses.* It was formerly employed for the windows of houses instead of glass, and until lately, was used in the Russian ships of war, it being not so liable as glass to be broken, by

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What minerals most resemble mica, and how is mica distinguished from them ?—What are the varieties of mica ?—What are the uses of mica ?

the discharge of cannon. At the present time, it is used instead of horn or glass, in lanterns, and for enclosing objects for the microscope.

Lowry says, that in Siberia, mica is quarried, and employed for the purposes to which glass is applied in Europe.

*Species 2. LEUCITE.\**

*External characters.* Colours, greyish white, white, and reddish white; occurs in small angular masses, apparently rounded by attrition; also in crystals, whose sides are bounded by twenty-four equal and similar trapeziums; crystals sometimes elongated; angles often rounded; transparent, passing into opaque; lustre, shining vitreous; structure obscurely lamellar; scratches glass with difficulty: sp. gr. 2.47.

*Chemical characters.* Infusible alone; with borax, slowly dissolves into a diaphinous glass.

*Composition.* Silica 53.75; alumina 24.62; potash 21.35.—*Klaproth.*

It is found in the products of volcanoes, which circumstance will serve to distinguish it from the minerals it most resembles.

*Localities.* Italy and Bohemia, in basalt and lava. The road from Rome to Frascati, is said in many places to be covered with it.

*Species 3. ANDALUCITE.†*

*External characters.* Colour, reddish, or purplish red; occurs massive and in rectangular, or slightly rhombic prisms; structure lamellar, with joints parallel to the sides of a rhombic prism; translucent or opaque; easily frangible: sp. gr. about 3; scratches quartz, and sometimes spinelle.

*Chemical characters.* Infusible alone, with borax melts into a limpid glass.

*Composition.* Alumina 52; silica 38; potash 8; oxide of iron 2.—*Vauquelin.*

*Distinctive characters.* It is distinguished from felspar, by its greater hardness and higher specific gravity, and from corundum by its inferior specific gravity and its form.—*Jamieson.*

It is found in primitive rocks only.

\* Signifying a white stone.

† From Andalusia, in Spain, where it was first found.

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What are the colours and crystalline forms of leucite?—In what situations is leucite found?

*Localities.* Andalusia, in Spain. Forez, in France, in a vein of felspar. Near Freyberg, and at Penig, in Saxony. Wicklow and Kilkenny, in Ireland.

U. S. Readfield, in Maine.—*Cleaveland.* East Bradford, Penn.

*Species 4. BUCHOLZITE.\**

*External characters.* Colours, black, and white, arranged in spots; occurs amorphous; lustre glittering, and glassy, or sometimes waxy; the black part separates into fibres; cross fracture conchoidal; structure indistinctly lamellar; fragments wedge-shaped; opaque or translucent on the edges; scratches glass.

*Composition.* Alumine 50; silice 46; potash 1.5; oxide of iron 2.5.—*Brandes.*

*Localities.* The Tyrol. First noticed by Dr. Brandes.

U. S. Brandywine creek, Del.—*Nuttall.*

*Species 5. ICHTHYOPHTHALMITE.† APOPHYLLITE.*

*External characters.* Colours, white, greyish white, greenish, or rose red; occurs in square prismatic crystals, and in laminated masses; crystals often truncated on the solid angles, by triangular planes, so as to give them a four-sided pyramidal termination; lustre glistening and pearly; structure foliated and easily separable into thin shining plates, like those of selenite; brittle; translucent or nearly transparent: sp. gr. about 2.5.

*Chemical characters.* Exfoliates, and finally melts into a blebby glass. In nitric acid, divides into flakes.

*Composition.* Silice 51; lime 28; potash 4; water 17.—*Vauquelin.*

*Distinctive characters.* It resembles adularia, sulphate of strontian, and barytes. It is much softer than the first, and does not like barytes give a fetid taste when melted, nor like strontian a sour one. Neither of these substances form flakes in nitric acid.

*Localities.* Utö, in Sweden, in a lamellar limestone. Arendal, in Norway. East Gothland. Fassa, in the Tyrol, and in the Isle of Sky.

\* After Bucholz, the chemist.

† From the Greek, meaning fish-eye-stone, owing to its peculiar lustre.

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What are the most obvious characters of bucholzite?—Whence does ichthyophthalmite derive its name?—How is apophyllite distinguished from the minerals it most resembles?

U. S. Near Lake Champlain, N. Y.—*Cleaveland*. Near  
aybrook, Conn.—*Gibbs*.

*Variety 1. ALBIN.\**

*External characters.* Colour, opake white; occurs in  
crystalline and laminated masses; forms a jelly with nitric  
acid; found in Bohemia.

*Species 6. NACRITE.†*

*External characters.* Colours, pearl white, greenish, or  
grey; occurs in minute aggregated scales; lustre pearly;  
friable; unctuous to the touch; adheres to the fingers; gives  
out an argillaceous odour when breathed on; swells on being  
moistened.

*Chemical characters.* Swells, and melts with ease.

*Composition.* Silica 50; alumina 26; lime 1.5; potash 17.  
5; oxide of iron 5; and a trace of muriatic acid.—*Vauquelin*.

*Distinctive characters.* Lepidolite, which it resembles, is  
of a lilac colour, and not so unctuous. It is more easily fused  
than talc, and never is of so dark a colour as chlorite.

It is met with in small masses in the cavities of primitive  
rocks, and particularly in quartz.

*Localities.* Near Freyberg, in Saxony. At Piedmont, and  
in Bohemia.

U. S. Farmington, Conn. Smithfield, R. I.

*Species 7. HAUYNE‡*

*External characters.* Colours, indigo blue, and opake,  
or bluish green, and translucent; occurs in grains, in  
crystals, and massive; form the dodecahedron, with brilliant  
faces; harder than quartz; very brittle; structure imperfectly  
foliated; lustre vitreous: sp. gr. 3.

*Chemical characters.* Fusible with loss of colour into a po-  
rous glass; with borax into a diaphanous glass, which turns  
yellow on cooling. In powder, it forms a jelly with acids.

*Composition.* Silica 30; alumina 15; sulphate of lime 20.  
5; lime 5; potash 11; oxide of iron 1; water 17.5.—*Phil-  
lips*.

*Localities.* In the vicinity of Nemi, Albano, and Frascati,

\* From the Latin, *albus*, white.

† From the French, *nacre*, pearl.

‡ In honor of the celebrated Haüy.

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Where is this mineral found in this country?—What is the appearance  
of nacrite, and in what situations is it found?

in Italy, associated with mica, leucite, and augite. Also near Vesuvius, and Tiree, one of the Scottish Isles, in limestone.

*Species 8. OBSIDIAN.*

*External characters.* Colours, black, greyish, or brownish black; also, greenish, bluish, or yellow; occurs in roundish, or angular masses; fracture large conchoidal, with round circular lines, increasing in dimensions from the point of fracture; lustre splendid and vitreous; translucent on the edges, or opaque; scratches glass; easily broken, and flies like glass: sp. gr. about 2.35.

*Chemical characters.* Swells, and finally melts into a spongy mass. It does not melt into a solid glass even at a white heat.

*Composition.* (That of Hecla.) Silica 78; alumina 10; potash 6; lime 1; oxide of iron and manganese 3.6.—*Vauquelin*.

Obsidian in its aspect, fracture, and lustre, very much resembles coloured glass, as the thick part of a broken junk bottle. It also may resemble pitchstone.

Sometimes it is variegated, presenting several colours in the same specimen, and some pieces exhibit a play of colours, with a pearly lustre.

The origin of obsidian has been a subject of considerable doubt and dispute among mineralogists. Some supposed from the circumstance of its being commonly found in the vicinity of volcanoes, that it is of igneous origin, and that, indeed, it is only a mixture of siliceous and alkaline substances reduced to glass by volcanic fire, hence it is often called *volcanic glass*.

On the contrary, obsidian has occasionally been found with the remains of decomposed granite, gneiss, and porphyry, and even alternating with beds of the latter. Other mineralogists, therefore, suppose that it is of aqueous origin.—*See Pinkerton's Petrology*.

But it is said, that wherever obsidian has been found, there always exists marks of volcanic agency in the neighbourhood; so that on the whole, there is little doubt but this substance owes its origin to volcanic heat.

*Localities.* Hecla, and in almost every part of Iceland. Also in the Lipari Islands, in Teneriffe, Peru, Mexico, &c.

*Variety 1. PEARLSTONE.\**

*External characters.* Colours, grey, greyish black, brown-

\* From its pearly lustre.

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What are the colours of obsidian and what common substance does it most resemble?—What is the most probable origin of obsidian?

sh, reddish, or yellowish; occurs in large, coarse, angular concretions, consisting of grains or smaller concretions, composed of lamellæ; concretions often embrace a nucleus of obsidian; surface smooth and shining; lustre pearly; translucent on the edges, or opaque; scratches glass; very fragile; gives an argillaceous odour, when breathed on: sp. gr. 2.34.

*Chemical characters.* Fusible with intumescence into a white frothy glass.

*Composition.* Silex 75.25; alumine 12; lime 0.5; potash 4.5; oxide of iron 1.6; water 4.5; potash 4.5; oxide of iron 1.6; water 4.5.—*Klaproth.*

Pearlstone occurs in the same geological situations with obsidian, and the same arguments and objections are brought for, and against its igneous and aqueous origin.

*Localities.* Tokay, in Hungary, where it is found enclosing black masses of obsidian. Cape de Gatt, in Spain. Antrim, in Ireland, &c.

*Species 9. GIESECKITE.—Stromeyer.*

*External characters.* Colours, externally brownish, internally greenish, intermixed with black; occurs in six-sided prisms; fracture uneven, splintery; cleavage not perceptible; lustre waxy; has the appearance of soapstone, more than of a crystalline mineral; opaque or translucent on the edges; yields to the knife; streak whitish; scratches glass: sp. gr. 2.7 to 2.9.

*Composition.* Silex 46.27; alumine 38.82; magnesia 1.2; potash 6.2; oxide of iron 3.35; water 4.8.—*Stromeyer.*

*Locality.* Greenland, from whence it was brought by Sir C. Giesecke. Hence the name.

*Species 10. FELSPAR.\**

Few minerals are more widely diffused than this. It forms a necessary part of most primitive and many secondary rocks. Its colours are various, but it has a peculiar lustre, and a foliated structure, by which it is easy to distinguish it from other minerals.

It has several varieties, which all agree in respect to structure and peculiarity of lustre.

\* From the German, signifying *feld-spar*, from its being often found loose in fields.

What is supposed to be the origin of pearlstone?—Why is this variety called pearlstone?—Whence does felspar derive its name?

*Variety 1. COMMON FELSPAR.*

*External characters.* Colours, white, yellowish, grey, brown, bluish, red, and green ; occurs massive, disseminated, and crystallized ; form, an oblique prism, the sides of which are unequal, and vary from four to ten in number ; primitive form, the oblique paralleliped ; common forms, a broad six-sided prism, terminated by dihedral summits, the planes of which stand on the narrow faces of the prism ; an oblique four-sided prism, flatly bevelled on the extremities ; a six-sided prism, terminated by five unequal faces ; structure foliated ; cleavage in two directions ; lustre shining, and often pearly ; translucent ; the dark varieties nearly opaque ; cross fracture conchoidal ; fragments rhomboidal ; crystals generally indistinct, and closely aggregated, crossing each other, or forming hemitropes : scratches glass : sp. gr. 2.54.

Fig. 134.



Fig. 134. An oblique paralleliped, the primitive form.

Fig. 135.

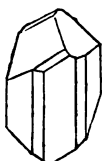


Fig. 135. A short six-sided prism, truncated on four of its lateral edges, forming a ten-sided crystal, with alternate broad and narrow faces, and terminated by four unequal planes.

*Chemical characters.* Fusible into a white translucent enamel.

*Composition.* Silica 62.83 ; alumina 17 ; potash 13 ; lime 3 ; oxide of iron 1.—*Vauquelin*.

There is considerable difference in the composition of different varieties of this species, and particularly in respect to the quantity of alumina, and potash which they contain.

This variety is very generally diffused, and perhaps is more common than any other mineral, with the exception of quartz, the ores of iron, and carbonate of lime.

It forms a constituent part of gneiss, granite, and mica-slate,

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What are the colours of common felspar ?—What are its crystalline forms ?—What is the composition of felspar ?—Is felspar a common or a rare mineral ?

among primitive rocks ; and of greenstone, and most volcanic substances, among those of secondary formations. It also occurs in porphyry and sienite.

Felspar, according to Pinkerton, intermixed with small quantities of other minerals, forms entire mountains in several parts of the globe.

Felspar with garnets, forms a mountain in the west of Scotland. In Siberia, the common foliated felspar, forms entire mountains. In the north of Scotland, there are mountains, and large strata of the same mineral.

*Variety 2.* ADULARIA. MOON-STONE.

*External characters.* Colours, white, bluish white, sometimes with tints of green, yellow or red ; occurs in rolled masses, in crystals of the forms above described, and disseminated in granite ; lustre pearly, and especially when cut and polished, it throws out greenish and bluish white chatoyant reflections from the interior ; fracture uneven ; cleavage in two directions ; crystals often present the hemitrope arrangement, which in polished specimens becomes obvious from the different directions of the grain, or laminæ : sp. gr. 2.54.

*Chemical characters.* Fusible into a transparent glass.

*Composition.* Silica 64 ; alumina 20 ; lime 2 ; potash 14.

—*Vauquelin.*

*Distinctive characters.* From common felspar into which it passes, it differs in being more translucent, and in displaying strong pearly reflections. Cat's eye is harder, and has not its foliated structure ; it is harder than ichthyophthalmite, strontian, or barytes, the two last also possess peculiar chemical properties. Spodumene splits and fuses when heated.

Adularia is found in cavities of granite, gneiss, clay-slate, and limestone.

*Localities.* St. Gothard yields the finest specimens, sometimes a foot in thickness. Beautiful specimens also come from Ceylon.

U. S. Ticonderoga, N. Y. of a milk white colour, also on the margin of Lake Champlain, at a place called Split-rock.

—*Hall.* Near Baltimore, Md.—*Gilmor.* Germantown and Conestoga creek, Penn. Haddam, Conn. Near the city of New York. Southampton, Oakham, and West Springfield, Mass.

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What is adularia a variety of?—How does adularia differ from felspar?—In what situations does adularia occur?—Where is it found in this country?



According to Jameson, the water opal, and the fire opal of the Italians, as well as the sun-stone, which is distinguished by its red colour and beautiful silvery reflections, are varieties of adularia.

*Uses.* Adularia is sometimes polished for jewelry. It is commonly cut with a convex surface like the cat's eye, but is easily distinguished from it, by observing that the reflections proceed from particular points on a plane surface, whereas in the cat's-eye, the pearly light is obvious in every direction.

*Variety 3. GLASSY-FELSPAR.*

*External characters.* Colours greyish, or yellowish white ; occurs commonly in broad four-sided crystals, terminated by two planes ; lustre vitreous, or glassy ; crystals cracked in various directions ; transparent or translucent.

*Localities.* Solfatera, Bohemia, and Hungary, in pumice. Isle of Arran, in Scotland, in pitchstone.

*Variety 4. LABRADOR FELSPAR.*

*External characters.* Colours, smoke grey, with spots of opalescent, or iridescent, variable tints, consisting of blue, fire red, green, brown, yellow, or orange, according to the direction in which the light falls upon it ; sometimes several of these colours are perceptible at the same instant, but more commonly they appear in succession, as the stone is turned towards the light ; occurs massive ; structure like that of common felspar, and easily recognized as one of that family.

This most beautiful variety was discovered by the Moravian Missionaries, on the Island of St. Paul, situated on the coast of Labrador.

Dr. Anderson, who gave an account of this mineral, soon after its discovery, describes it as displaying all the variegated tints of colour that are to be seen in the plumage of the peacock, pigeon, or most delicate humming-bird.

Specimens of it being sent to England, they were bought with great avidity, and the desire among the collectors all over Europe, to possess specimens was so great, that single pieces were sold at £20 sterling.

*Localities.* Near Petersburg, Russia. Near Laurwig, in Norway. Bohemia, Saxony, and Labrador.

U. S. Near Lake Champlain, N. Y. in an iron mine.—

*Gibbs.* Near Pompton Hills, N. J. in a large rounded mass. That of Labrador often contains magnetic oxide of iron.

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What is the use of adularia ?—What are the peculiarities of Labrador felspar ?—Where was this mineral first discovered ?

*Uses.* It is highly valued as a curiosity, and is cut and polished for ring stones, and breast-pins. When cut in an oblong convex shape, or *en cabochon*, as the French term it, most of the colours are apparent at the same instant. When held between the eye and the light, it appears of a dingy grey colour, and without the least beauty, and one is the more astonished after viewing it in this manner, to witness the beautiful display of colours which it exhibits by the reflected light.

*Variety 5. GREEN FELSPAR.*

*External characters.* Colour, apple green; occurs in the common form of the species. It is called *Amazon Stone*.

*Localities.* Uralian Mountains.

U. S. Near Baltimore, Md. in granite. At Cow Bay, on Long Island, N. Y. colour apple green.—*Pierce* and *Torrey*. Topsham, Maine, in imperfect crystals.—*Cleveland*.

*Variety 6. COMPACT FELSPAR.*

*External characters.* Colour, white, bluish white, greenish, reddish, brown and flesh red, colours sometimes arranged in spot or stripes; occurs massive, disseminated, and in crystals; texture compact, or minutely foliated; fracture conchoidal; lustre glimmering; translucent on the edges: sp. gr. from 2.60 to 2.74.

*Chemical characters.* Fusible alone into a white porous enamel.

*Composition.* Silica 51; alumina 30; lime 11.25; soda 4; oxide of iron 1.75; water 1.26.—*Klaproth*.

It is one of the constituent parts of primitive, transition, and secondary rocks. It sometimes occurs in large beds, or even forms hills.

*Localities.* Saxony, Tyrol, Scotland, &c.

U. S. In the Fishkill Mountains, N. Y. in gneiss. Malden, Dorchester, and Milton, Mass. Colours, sometimes red and white, arranged in veins.

This variety resembles hornstone, and sometimes jasper.

According to M. Godon, as quoted by *Cleveland*, the vicinity of Boston furnishes compact felspar, perfectly analogous to the Turkey stone (hone); and also a veined variety, which strongly resembles certain antique engraved stones wrought by the Greeks and Romans in *basso-relievo*.

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What use is made of Labrador felspar?—What other varieties of felspar are described?

*Variety 7. FETID FELSPAR.*

Necronite.\*—Hayden. Sill. Jour. Sci. Vol. ii.

*External characters.* Colour, clear white, or bluish white; occurs amorphous, and crystallized in hexahedral prisms, resembling the beryl, and in rhomboids similar to the form of felspar; structure lamellar; transparent, passing into opaque; scratches glass, and even felspar in a slight degree; when struck, or pounded, emits a most noisome cadaverous smell.

*Chemical characters.* Infusible, and unalterable even with borax in the strongest heat of a smith's furnace. Acids do not affect it, either cold or hot.

*Locality.* This mineral appears to have been first described by Dr. Hayden, of Baltimore, who discovered it in 1819, about 21 miles from that city. It occurs in primitive marble, associated with brown mica, sulphuret of iron, and tremolite.

*Variety 10. ANORTHITE.—Rose.*

*External characters.* Colour, and streak, white; occurs massive, composed of rhomboidal prismatic, aggregated crystals, resembling those of albite; cleavage perfect in two directions; fracture conchoidal; lustre upon the planes of cleavage, pearly; in other directions vitreous; translucent or transparent; hardness, that of felspar: sp. gr. 2.65 to 2.76.

*Chemical characters.* Fusible like the other varieties of the species, the globule being turbid.

*Composition.* Silica 44.49; alumina 34.46; oxide of iron 0.74; lime 15.68; magnesia 5.26.—Rose.

*Distinctive characters.* It is entirely decomposed by concentrated muriatic acid.

*Locality.* Mount Vesuvius, lining the cavities of limestone, and associated with augite.

This mineral has recently been discovered.

*Species 11. TALC.*

*External characters.* Colours, green of various shades, as emerald, or apple green, or greenish white; occurs massive, consisting of thin folia easily separable with the fingers, also indurated and in crystals; lustre shining; translucent; in thin plates transparent; soft, and very unctuous to the touch; yields easily to the nail; folia curved, undulated, or straight; lustre shining, pearly; colour of the thin lamina white.

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\* From the Greek, in allusion to its cadaverous smell.

**Chemical characters.** Before the blowpipe it turns white, the laminæ separate, and the thin fibres become glazed. With borax it melts with effervescence into a greenish transparent glass.

**Composition.** Silica 61 ; magnesia 30.5 ; potash 2.75 ; oxide of iron 2.5 ; water 0.5.—*Klaproth*.

**Distinctive characters.** It resembles mica, but this is both flexible and elastic, while talc is elastic but not flexible. Chlorite and nacrite are fusible without difficulty. Its unctuousity will also distinguish it from these substances, and from selenite, and cyanite.

It occurs in primitive rocks, as granite and serpentine, and though common in small quantities, is never very abundant.

**Localities.** U. S. Grafton, Windham, Cavendish, Ludlow, &c. Ver.—*Hall*. Smithfield, silvery white, with rhomb spar.—*Webb*. Near Baltimore, Md. fibrous, ligniform, and foliated.—*Hayden*. Delaware County, Penn. sometimes crystallized ; also on the Schuylkill, ten miles from Philadelphia, of a fine green colour, with rhomb spar.—*Lea*. Had-dam and Litchfield, Conn. Southampton, Cummington, and Middlefield, Mass. Brunswick, Maine, in limestone, with actynolite ; colours, silver white, and apple green.—*Cleveland*.

#### Variety 1. INDURATED TALC.

**External characters.** Colour, greenish grey ; occurs massive ; texture compact ; structure slaty ; lustre a little pearly ; less soft and unctuous than common talc ; translucent on the edges ; insensibly passes into steatite. It is found in primitive mountains, in clay-slate and serpentine.

**Localities.** Austria, the Tyrol, Switzerland, Scotland, &c.

**Distinctive characters.** It has a strong resemblance to pot-stone, but is more unctuous, and less hard.

**Uses.** This variety is employed by tailors, to trace out their work on woollen cloth.

#### Species 12. STEATITE. SOAPSTONE.

**External characters.** Colours, various shades of green, grey, white, yellow, and red, and always dull ; grey and white are the most common ; colours commonly arranged in spots,

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What are the chemical characters of talc ?—How is talc distinguished from the minerals it most resembles ?—Is talc rough or unctuous to the touch ?—What is the use of indurated talc ?—What are the most obvious characters of soapstone ?

veins, or clouds; occurs massive, forming large beds, or hills; fracture splintery, or uneven, with marks of confused crystallization on close inspection; yields easily to the knife, and may be cut when first taken from the quarry; unctuous to the touch; translucent on the edges; leaves a shining streak: sp. gr. about 2.50.

*Chemical characters.* Hardens, turns black, but is hardly fusible.

*Composition.* Silica 64; magnesia 22; oxide of iron 3; water 5.—*Vauquelin*.

Soapstone sometimes presents pseudo-morphous crystals, in the form of carbonate of lime or quartz, which appear to have been moulded into cavities once occupied by true crystals.

*Distinctive characters.* It is less unctuous to the touch than indurated talc, into which it passes. Jameson observes, that the white variety approaches to lithomarge, and the green to fuller's earth, but both of these are softer and adhere to the tongue. Serpentine is harder than steatite, and not so unctuous.

Steatite occurs in masses, and in beds of considerable extent, in primitive mountains. Sometimes according to Pinkerton, it forms mountains or hills of considerable dimensions.

*Localities.* Cornwall, in England. Bohemia, Scotland, Spain, Hebrides, &c.

U. S. New Haven, Litchfield, and Somers, Conn. At the latter place it is quarried extensively. On the Schuylkill, ten miles from Philadelphia, Penn. It is extensively employed. Staten Island, N. Y. in abundance. Smithfield, R. I. It is employed in the arts.—*Eaton*. Grafton, Ver. This steatite is employed in the construction of aqueducts.—*Hall*. Orford, N. H. It occurs in large quantities, and is extensively employed.—*Hall*. Near the Falls of St. Anthony, Louisiana.

According to Pinkerton, the Arabs made use of soapstone instead of soap.

The inhabitants of New Caledonia, it is confidently said, either eat a soft kind of soapstone alone, or mix it with their food.

Humboldt says, that a certain race of inhabitants on the Oronoko, are almost entirely supported by a kind of soapstone, for three months of the year.

*Uses.* Soapstone is extensively employed in the arts of life, for various purposes. It is soft, and well fitted for turning, cutting, or sawing. It is bored for aqueducts, and will proba-

bly come into general use for this purpose, being much cheaper than lead, and without the least deleterious property. It resists the fire, and is well calculated for the backs of chimneys, and the sides of fire places, &c. After being heated, it will receive a tolerable polish, and might be employed for jambs instead of marble.

*Variety 1. POTSTONE.*

*External characters.* Colours, greenish grey, passing into leek green, often spotted; occurs massive; texture compact; structure slaty; unctuous to the touch; often yields to the nail; not easily broken; lustre glistening; opaque; fracture earthy, or uneven; odour argillaceous: sp. gr. nearly 3.

*Composition.* Silica 38; magnesia 35; iron 15; alumina 7; with a little lime and fluoric acid.—*Weiglb.*

It is found with serpentine, argillite, and soapstone.

*Locality.* Como, in Lombardy, where it has been quarried more or less, ever since the days of Pliny, and turned into culinary vessels. Hence the name *potstone*.

It is often difficult to distinguish potstone, from indurated talc and soapstone. It is, however, commonly less unctuous than the former, and more compact and finer grained than the latter.

*Variety 2. AGALMATOLITE. CHINESE FIGURE STONE.*

*External characters.* Colour, greenish, or yellowish green; sometimes with veins of lilac, or brown; occurs massive; greasy to the touch; translucent; texture compact; easily cut with the knife; receives a polish: sp. gr. 2.8.

*Chemical characters.* Whitens and becomes opaque, but does not melt.

*Composition.* Silica 56; alumina 29; lime 2; potash 7; oxide of iron 1; water 5.—*Vauquelin.*

*Distinctive characters.* It resembles nephrite in colour, translucency; and texture, but is much softer.

It comes from China, carved into the form of grotesque images, and chimney ornaments. It is also found in Nagyag, in Transylvania, and in Wales.

*Species 13. CHLORITE.*

Chlorite occurs crystallized, compact, slaty, and earthy. As its name signifies, it is always of a green colour, usually dark; it is slightly unctuous to the touch, but much less so

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\* What are the uses of soapstone?—How does potstone differ from soapstone?—What is said of Chinese figure stone?—What are the forms in which chlorite occurs?—What are the colours of chlorite?

than talc. When moistened it commonly yields the odour of clay. Most varieties yield to the nail.

**Variety 1. CRYSTALLIZED CHLORITE.**

*External characters.* Colour, dark leek green; occurs in flat six-sided crystals; structure foliated, and readily divisible into thin layers; lustre shining; crystals occur separate and intersecting each other, in small masses, or investing other minerals.

*Chemical characters.* Fusible with difficulty into an ash-grey scoria. With borax forms a green glass.

It is found in the veins and cavities of primitive rocks, with chalcedony, axinite, feldspar, &c.

**Variety 2. COMMON CHLORITE.**

*External characters.* Colours, leek green, or blackish green; occurs massive, composed of minute scales, or of an earthy texture; lustre shining, or glimmering; slightly unctuous; yields to the nail: sp. gr. from 2.6 to 2.9.

*Chemical characters.* The same as above.

*Composition.* Silica 26; magnesia 8; alumina 18.5; oxide of iron 43; muriate of soda and potash 2.0; water 2.—*Vauquelin*.

There is much difference in the proportions of these ingredients. Lampadius obtained only 9.7 oxide of iron, and Hoepfner obtained magnesia 39.47.

*Distinctive characters.* It is of a darker green than talc, or epidote. Nacrite is easily fusible, and potstone is of a more compact texture.

*Localities.* St. Gothard, England, Scotland, Saxony, &c. It is a common mineral.

U. S. Harper's Ferry, Vir. Chester county, Penn. Rye, N. Y. containing long and slender crystals of schorl. New Haven, Brookfield, and Saybrook, Conn. At the latter place, in small crystals.—*Porter*. Charlestown, Brighton, Bridgewater, and West Stockbridge, Mass. Topsham, Maine.

**Variety 3. CHLORITE SLATE.**

*External characters.* Colours, green, blackish green, or greenish grey; structure slaty, or foliated; layers often curved; opaque; occurs massive; appears on inspection to be composed of minute scales; lustre glistening; easily cut with a knife; slightly unctuous to the touch.

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What are the chemical characters of chlorite?

**Distinctive characters.** From mica slate, it is known by its unctuousity and colour, and from argillite and greenstone slate, by its softness, as well as the above named qualities. Talc and soapstone are more unctuous to the touch than chlorite.

This variety is found in beds, in primitive mountains, and often contains crystals of mica, magnetic iron, garnets, &c.

**Localities.** U. S. Williamstown, Mass. also at Westfield, containing crystals of mica.—*Dewey*. Near New-Haven, and West-Haven, Conn. the latter abounding with magnetic iron.—*Silliman*.

#### Variety 4. GREEN EARTH.

**External characters.** Colours, green of various shades, sometimes bluish or greyish green; occurs in small amorphous masses, or lining the cavities of amygdaloid or porphyry; fracture earthy; yields to the nail; adheres to the tongue; slightly unctuous: sp. gr. about 2.5.

**Chemical characters.** Fusible into a brownish black slag.

**Composition.** (From Verona.) Silica 53; magnesia 2; potash 10; oxide of iron 28; water 6.—*Klaproth*.

**Localities.** Bohemia, forming beds. Mount Pazzo, where it occurs in pseudomorphous crystals, of the form of augite. Near Verona, where it has been long explored.

U. S. Near Imlaytown, in Patterson, N. J. On the Hudson, N. Y. Near Boston, and at Deerfield, Mass. in amygdaloid.

**Uses.** Green earth is used both raw as a green colour, and burnt as a reddish brown colour, for painting houses, &c.—*Mohs*.

#### Species 14. TOURMALINE. SCHORL.

**External characters.** Colours, green, blue, yellow, black, and white; occurs in crystals and crystalline masses; form, six, nine, or twelve-sided prisms, or six-sided prisms so truncated as to appear under six, nine, twelve, or even twenty-four faces. The terminations are various, and commonly differ in the number and size of the faces at the two ends; crystals long, striated, and complete, or aggregated into irregular masses, their terminations not being obvious; translucent or opaque; scratches glass; electric when heated; the end having the greatest number of faces being positive; the other negative: sp. gr. about 3.

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How is chlorite slate distinguished from the minerals it most resembles?—What are the varieties of chlorite?—What are the uses of green earth?—What are the colours of tourmaline?



Fig. 136.



Fig. 136. A nine-sided prism, obtusely terminated by five planes. Only four of the sides and two of the planes are obvious in the figure.

Fig. 137.



Fig. 137. A three-sided prism, truncated on its lateral edges so as to present nine unequal sides, and terminated by three principal faces, to which a fourth is added by the truncation of one of the solid angles.

**Variety 1. BLACK TOURMALINE. COMMON SCHORL.**

*External characters.* Colours, velvet black, or brownish black; occurs massive, disseminated and crystallized, in three, six, or nine-sided prisms, variously bevelled or truncated, and obtusely terminated by an uncertain number of planes; crystal striated; opaque; lustre shining, or nearly glistening; brittle: sp. gr. 3.

*Chemical characters.* Fusible with ease into a brownish slag. With borax, it is singular that so deep a coloured mineral, should form a nearly colourless and transparent glass.

*Composition.* Silica 38; alumina 34; magnesia 1; potash 6; oxide of iron 21; manganese, a trace.—*Klaproth.*

Schorl is a very common mineral, but it never occurs in such quantities as to form the principal part of rocks. It is disseminated in crystals, and in small masses, in primitive rocks, as granite, and quartz.

The crystals, though described as six, nine, or twelve-sided prisms, are commonly triangular, having three principal sides, which on inspection will be found to contain several plane faces each.

Black tourmaline is often a very beautiful mineral. The crystals are of all sizes, from that of a small needle, to several inches in diameter. These are often long, straight, and perfect, and when occurring in milk white quartz, produce a very handsome effect, by the contrast of colour.

*Distinctive characters.* Schorl resembles hornblende; but

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What are the forms of its crystals?—What are the chemical characters of tourmaline?—What is said of the electrical properties of tourmaline?

schorl has a vitreous lustre, a conchoidal or uneven fracture, and is electric by heat. Hornblende has a splintery fracture, a laminated structure, is softer than schorl, and is non-electric. Schorl is found chiefly in granite and quartz, sometimes in gneiss and mica slate.

*Localities.* Schorlaw, in Saxony, where it was first found, and hence its name. Bohemia, Bavaria, Switzerland, Spain, Hungary, &c.

U. S. Grafton, Brattleborough, and Stafford, Ver. Near Baltimore, Md. crystals sometimes more than three inches in circumference.—*Gilmor.* Rhinebeck and Kingsbridge, N.Y. Haddam and Litchfield, Conn. Hallowell, Litchfield, Bowdoin, Maine.

*Variety 2.* GREEN TOURMALINE.

*External characters.* Colour, bluish green, passing into dark leek green; occurs under the forms above described; translucent or opaque; electric by heat.

*Localities.* Ceylon, Brazil, St. Gothard, in Switzerland, and in Sweden.

U. S. Chesterfield, Mass. in a vein of quartz and felspar, traversing granite. The green tourmaline often encloses a prism of rose coloured *rubellite* running through its axis. The crystals of tourmaline are sometimes four inches long. The same granite contains the blue tourmaline and emerald.—*Gibbs.* Also at Paris, in Maine.

*Variety 3.* YELLOW TOURMALINE.

*External characters.* Colour, honey, or orange yellow; translucent or transparent; other characters common to the species.

*Localities.* Ceylon.

U. S. Near Baltimore, Md. in primitive limestone. Chester county, Penn. in transparent crystals with oxide of titanium. Dalton, Mass. colour straw yellow, and from one to two inches long.

*Variety 4.* INDICOLITE.\*

*External characters.* Colour, indigo blue, often very dark; occurs crystallized in the form of the species, but commonly less perfectly.

\* From its colour, being that of indigo.

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What are the distinctive characters of tourmaline?—What is said of the green tourmaline of Chesterfield?—Where is yellow tourmaline found?—What is indicolite?

*Localities.* Utoe, in Sweden, of an indeterminate form.

U. S. Harlæm Heights, N. Y. Goshen and Chesterfield, Mass. crystals often of so deep a colour as to appear black. Bellows Falls, Ver. in primitive rocks. Hinsdale, N. H. in large crystals.—*Silliman.*

*Variety 5. WHITE TOURMALINE.*

*Localities.* This rare variety occurs at St. Gothard, Elba and Siberia.

U. S. Paris, Maine.

*Variety 6. RUBELLITE.\* RED TOURMALINE.*

*External characters.* Colours, red, pink, crimson, violet or rose red; occurs under the same forms as the species crystals not often distinct, being closely aggregated into groups or variously crossing and intersecting each other; translucent or transparent; harder than the other varieties.

*Chemical characters.* Splits, intumesces, turns white, does not fuse, but vitrifies on the edges; with borax affords a transparent glass.

*Composition.* Silica 42; alumina 40; soda 10; oxide of manganese and iron 7.—*Vauquelin.*

*Distinctive characters.* Its fine colour and its form will distinguish it from all other minerals of this species.

*Localities.* Ceylon, with lepidolite. Moravia, Ural mountains, Ava, and Sweden.

U. S. Chesterfield, Mass. in red crystals, often surrounded or embraced by crystals of green tourmaline; also in Goshen, Mass. with lepidolite, or rose red mica. Kingsbridge, 12 miles from the city of New-York. Paris, Maine.

It is sometimes cut and polished, and worn as a jewel, but is not highly esteemed.

Fine specimens of rubellite, on account of their variety and beauty, sometimes sell at great prices. Thus Jameson saw a three-sided prism of rubellite, of an inch in diameter, at Dresden, which cost 400 rubles, and in the collection of Mr. Gravelle, which he sold to the British government, there was a specimen of the same mineral valued at £1000 sterling.

*Species 20. SOMMITE.†*

*External characters.* Colours, greyish, or greenish white;

\* From its being of a ruby red colour.

† From its occurring on Monte Somma.

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What is the colour of rubellite? What is the composition of rubellite?  
—What is said of the prices of some rubellites?—Whence comes the name of sommite?

occurs in small crystals and crystalline grains; form, a regular six-sided prism, with the lateral edges and terminal angles often replaced; cleavage parallel to the planes of the prism; cross fracture conchoidal; lustre shining, vitreous; scratches glass: sp. gr. about 3.2.

*Chemical characters.* Fusible into a blebby colourless glass. Renders nitrous acid cloudy, when immersed in it.

*Composition.* Silex 44.11; alumine 33.73; soda 20.46; loss 0.62.—*Arfwedson.*

*Distinctive characters.* It resembles phosphate of lime, but is harder and does not phosphoresce on hot coals.

*Localities.* Mount Somma, near Vesuvius, with mica and idocrase. Near Rome, in lava.

*Species 21. ANALCIME.\**

*External characters.* Colours, white, grey, yellowish, or deep red; occurs crystallized in cubes, either perfect, or having its solid angles replaced by three planes; also, in twenty-four sided crystals, the faces of which present trapezoidal figures, like those bounding the sides of the garnet; scratches glass; transparent or translucent, and sometimes opaque; crystals often implanted and grouped; lustre shining and pearly; by friction acquires a weak electricity: sp. gr. about 2.25.

*Chemical characters.* Fusible without intumescence into a diaphanous glass.

*Composition.* Silex 58; alumine 18, lime 2; soda 10; water 8.5.—*Vauquelin.*

*Distinctive characters.* Leucite, which it resembles, commonly occurs in distinct crystals, or small masses, and never in implanted groups like the present species; leucite is also infusible. The garnet, which the red variety resembles, is much harder and heavier. Fluor-spar melts into a white globule, carbonate of lime effervesces, and from stilbite, and zeolite, it differs in crystalline form.

It occurs in primitive rocks, and in trap, and lava.

*Localities.* Bohemia, in the Hartz, Iceland, Faroe islands, near Edinburgh, and in several other parts of Scotland, Ireland, &c.

U. S. Paterson, N. J. in greenstone. East Haven, Conn. with agates and chalcedony. Deerfield, Mass. in greenstone.

\* From the Greek, in allusion to its weak electric powers.

What are the colours of analcime?—What minerals does analcime most resemble, and how is it distinguished from them?

*Species 23. PITCHSTONE.*

*External characters.* Colours, grey, blue, green, yellow, red, brown, and black of various shades, but always dull; occurs massive, and in prismatic concretions; structure slaty, sometimes curved; lustre, resino-vitreous; fracture imperfectly conchoidal; opaque or translucent; scratches glass: sp. gr. from 2.32 to 2.64.

*Chemical characters.* Some few varieties are infusible, others melt into an enamel, the colour of which depends on that of the specimen.

*Composition.* Silica 73; alumina 14.5; lime 1; soda 1.75; oxide of iron 1; oxide of manganese 0.1; water 8.5.—*Klaproth.*

*Distinctive characters.* Its imperfectly conchoidal fracture will distinguish it from obsidian, which also has a more vitreous lustre than pitchstone. Its fusibility will distinguish it from flint, jasper, semi-opal, and hornstone.

It is found in primitive countries, also in trap rocks, in lava, and in formations of doubtful origin. Though generally found in veins and small masses, it sometimes forms whole mountains, as Kirwan states to be the case in Misnia; Pinkerton states the same fact in regard to certain mountains in Germany and New Spain.

*Localities.* Cairngorm, in Scotland. Germany, in many places. Ireland, near Dublin. Mexico, Teneriffe, &c.

U. S. Bare Hills, near Baltimore, Md. in serpentine.

Pinkerton mentions a pitchstone porphyry which occurs at Auvergne, in France. The base is dark bottle green, with lighter green crystals of felspar. In a specimen of this kind before me, the crystals of felspar often cross each other, or are set in the form of stars, and being of a light apple green, contrasted with the dark ground, forms a beautiful mineral.

*Species 24. LAVA.*

*External characters.* Colours, yellowish, or greenish grey, greyish black, or greenish black, sometimes sulphur yellow, and often spotted with red; occurs massive, with internal marks of fusion, being vesicular, or porous, the vesicles being empty; fracture more or less conchoidal, or fibrous; lustre glistening or shining; opaque, or feebly translucent on the edges; also compact, with a dull earthy fracture, and often containing crystals of felspar, leucite, hornblende, &c.; brittle; often attracts the magnet.

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What are the colours of pitchstone?—How is pitchstone distinguished from the minerals it most resembles?—What are the colours of lava?

*Chemical characters.* Fusible into a dark coloured glass.

*Composition.* (Compact lava.) Silica 51; alumina 19; lime 10; soda 4; iron 14; water 1.—*Phillips*.

*Distinctive characters.* Lava is heavier than pumice, and does not possess its fibrous aspect, nor its silky lustre.

It is found in volcanic countries only, and is the product of the action of volcanic fire on earthy minerals.

*Localities.* Etna, Vesuvius, Hecla, and most other volcanoes.

Werner and Jameson notice two kinds of lava, *slag lava*, and *foam lava*. Haüy enumerates six species, and Karsten nine. Many mineralogists, however, believe that some substances formerly included among the lavas, are not volcanic products, and consequently not true lavas.

Lava frequently includes crystals and other substances which are easily fusible, but which in appearance have not been altered by the fire; such are felspar and hornblende. On this account some mineralogists have doubted its volcanic origin.

The above description is intended to embrace only such substances as are undoubted lavas.

#### *Species 25. PUMICE.*

*External characters.* Colours, greyish or yellowish brown, or light smoke grey; occurs massive; structure fibrous; texture extremely porous; pores round, or elongated; lustre shining, pearly; very brittle; opaque, or translucent on the edges; scratches glass and steel; fracture fibrous, or imperfectly conchoidal; yields to the knife: sp. gr. 1.4, but is sometimes so light as to swim on water.

*Chemical characters.* Fusible into a yellowish green glass full of bubbles.

*Composition.* Silica 77.5; alumina 17.5; oxide of iron 1.75; potash and soda 3.—*Klaproth*.

Pumice is generally considered a volcanic product, though some geologists consider it an aqueous deposit. That it is sometimes of volcanic origin, there cannot be a doubt, as in some cases of submarine volcanoes, pumice has been formed, and floated on shore; but all volcanoes do not seem to produce it, as it is but sparingly found at Vesuvius, and not at all at Etna.

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How is lava distinguished from pumice?—What is the origin of lava?  
—What are the colours of pumice?—What is the origin of pumice?



Pumice often contains crystals of hornblende, felspar, quartz, mica, &c.

*Localities.* Auvergne, in France. Iceland, Teneriffe, Lipari, Hungary, &c.

The pumice of commerce comes chiefly from Lipari.

*Uses.* It is used under the name of pumice stone, for scouring brass, polishing certain metals and glass, and by cabinet makers for smoothing wood and varnish. In the countries where it is found, it is sometimes employed as a building stone.

#### *Species 26. BASALT.*

*External characters.* Colours, greyish black, brownish grey, or bluish black; occurs in large amorphous masses, or in globular, columnar, or tabular forms; fracture splintery, or coarse grained, uneven; sometimes conchoidal; lustre feebly glimmering, or dull; opaque; streak, ash grey; often porous, or vesicular; cavities sometimes of considerable size, of a flat, oblong, or round shape; often, also, porphyritic: sp. gr. from 2.8 to 3.

*Chemical characters.* Fusible into an opaque black glass. With borax it slowly dissolves into a greenish transparent glass.

*Composition.* (From Saxony.) Silica 44.5; alumina 16.75; lime 9.5; magnesia 2.25; soda 2.6; oxide of iron 20; oxide of manganese 0.12; water 2.—*Phillips.*

*Distinctive characters.* It is of a darker colour, and wants the greenish tinge of greenstone. And from indurated clay and argillite, it may generally be known from the difference of lustre and fracture, as well as from the vesicles and embedded minerals which it contains.

Basalt is often porphyritic, containing embedded crystals, as hornblende, olivine, felspar, quartz, mica, analcime, clay, &c. Sometimes its cavities are lined with incrustations of lime, steatite, and zeolite.

It frequently attracts the magnet, and is subject to decomposition, in consequence of the quantity of iron it contains.

#### *Variety 1. COLUMNAR BASALT.*

It occurs in columns of a prismatic form, having from three to nine plane sides or faces, but more commonly only five or six. These columns are of all sizes, from a few inches to several feet in diameter, and sometimes nearly a hundred feet

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What is the use of pumice?—What are the colours of basalt?—What are the chemical characters of basalt?

high, occasionally straight but oftener curved. The columns are jointed, or composed of many pieces of the same shape and dimensions, lying one on the other.\*

*Locality.* Giant's Causeway, north of Ireland.

*Variety 2.* GLOBULAR BASALT.

*External characters.* This variety occurs in tabular masses, from a few inches to several feet in diameter. They are composed of concentric spheres, or layers, one without the other, forming globes, which are filled with lesser globes, gradually diminishing in size to the centre. These spheres are cross-cracked, so as to give the mass a radiated structure.

Sometimes, says Mr. Bakewell in his geology, these spheres appear compressed against each other, so as to flatten their sides. At the centre they often contain a fragment of compact basalt, or some other substance, as a piece of shell limestone, as a nucleus.

Basalt is undoubtedly a secondary rock, but mineralogists disagree as to the mode of its formation. Some contend that nothing but fusion could have produced the crystalline form, and the vesicular structure of this rock; while others see no difficulty in accounting for these and other peculiarities, on the supposition of its aqueous origin, and contend that basalt is a deposit from water.

Notwithstanding the strong marks of fire which basalt seems to bear, there are many circumstances which discountenance its volcanic origin. It often contains substances apparently unaltered, which are easily fusible, as hornblende, felspar, and clay. It also embraces organic remains, both of animals and vegetables, and sometimes rests on coal, or bituminous wood, without leaving any marks of fire on these substances. Another strong argument against its volcanic origin is, that it frequently alternates with limestone, and sandstone.

On the whole, it is most probable that some basalts have originated from fire, and others from water. According to Phillips, the basalt of Germany is believed by most geologists, to be of Neptunian or aqueous origin, while that of France is universally acknowledged to be volcanic.

Probably the most remarkable locality of this rock existing, is that called the Giant's Causeway, in the north of Ireland.

\* See Bakewell's Geology.

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What is the form and appearance of globular basalt?—What is supposed to be the origin of basalt?—Where is the most remarkable locality of basalt?



At this place, a vast number of basaltic columns stand side ~~by~~ side, forming the walls of a gap, from the sea into the side ~~of~~ of the mountain. The area of this gap is about 600 feet long by 30 wide. The columns are mostly straight, and about 40 feet high.

Another very interesting locality of this mineral is at Cader Idris, in North Wales, where a vast number of these columns are lying in confusion on each other, as though they had been thrown down by some terrible convulsion. Bakewell has given a drawing of this scene.

*Species 27. JADE. NEPHRITE.*

*External characters.* Colours, mountain green, passing into dark grass-green, sometimes light sea green; occurs massive, and in rolled pebbles; fracture splintery; lustre glimmering, and greasy, when polished; translucent, sometimes only on the edges; unctuous to the touch; strongly coherent, and very difficult to break; scratches glass; structure compact; cleavage, none.

*Chemical characters.* Fusible into a greenish glass.

The descriptions of this mineral by different authors, are quite discordant. Kirwan says, jade is infusible by the strongest heat of a furnace. Haüy and Cleaveland say, it is easily fusible by the blowpipe. Aiken says, that it yields to the knife. Phillips, that it scratches quartz, &c.

In respect to composition, Kirwan gives, silex 47; magnesia 38; clay 4; lime 2; iron 9.

Saussure, silex 57.75; lime 12.75; alumine 1.5; oxide of iron 5; oxide of manganese 2; soda 10.75; potash 8.5; water 2.25.

These characters and compositions are so widely different, as to render it impossible that they should belong to the same species. It is most probable, therefore, that the same name has been applied to minerals of entirely distinct species.

The above specific description, applies to what the writer has considered undoubted specimens of jade.

*Uses.* Its great tenacity, observes Jameson, enables the artist to execute on it beautifully delicate figures without the risk of breaking. The Turks cut it into handles for sabres and daggers, which they prize highly. It is said even to have been wrought into chains.

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What are the colours of jade?—What are the peculiarities of jade?  
What are the uses of jade?

*Species 28. CHABASIE.\**

*External characters.* Colours, white, yellowish white, greyish, or pale red; occurs in crystals only; form, an obtuse rhomboid, scarcely to be distinguished from a cube, its alternate angles being  $94^{\circ}$  and  $86^{\circ}$ ; subject to various modifications; cleavage parallel to the planes of the rhomboid, scarcely scratches glass; translucent or transparent; structure lamellar; crystals often implanted, or set on other minerals; lustre vitreous: sp. gr. 2.7.

*Chemical characters.* Fusible with slight swelling into a white spongy mass. Acids do not act on it.

*Composition.* Silex 43.33; alumine 22.66; soda and potash 9.34; water 21; lime 3.34.—*Vauquelin.*

*Distinctive characters.* From carbonate of lime and zeolite, it differs in resisting the action of acids; fluor-spar, which it also resembles, is acted on by acids, phosphoresces when heated, and decrepitates, neither of which characters belongs to chabasie.

It is found chiefly in amygdaloid, basalt, and greenstone.

*Localities.* Oberstein, in Germany. Fassa. Island of Sky. The finest specimens come from the three first named places.

U. S. Deerfield, Mass. in greenstone, and balls of zeolite.—*Hitchcock.*

*Species 29. LEPIDOLITE.†*

*External characters.* Colours, lilac red, rose red, or pearl grey; occurs massive, presenting an aggregate of minute, shining, flexible scales, or hexagonal plates; fracture fine grained, splintery; lustre, glistening and pearly; yields to the knife with ease; in powder, unctuous to the touch: sp. gr. 2.8.

*Chemical characters.* Fusible with ease into a transparent globule, at the same time says Aiken, tinging the flame purplish red.

*Composition.* Silex 54; alumine 20.61; potash 9.6; oxide of manganese 0.5; lime 16; water 1.86.—*Vauquelin.*

Another variety yielded, says Prof. Gmelin, silex 52.254; alumine 28.345; oxide of manganese 3.602; potash 6.903; lithion 4.792; fluoric acid 3.609.

\*From the Greek, signifying a particular species of stone.

†From the Greek, signifying a scaly stone.

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What are the distinctive characters of chabasie?—In what rocks is chabasie found?—What are the colours of lepidolite?—Is lepidolite fusible, or infusible?

Prof. Gmelin, before the analysis, supposed this mineral to have been mica, crystallized in large laminae.—*Silliman's Journal*.

**Distinctive characters.** Its appearance much resembles an aggregation of small scales of mica, but mica melts into a greyish or black enamel, and is not unctuous to the touch.

Lepidolite is often a very handsome mineral. Its colour, approaching to that of peach blossom, in some instances, is remarkably soft and pleasant to the eye, while its scales are so disposed as to give it a glittering and brilliant lustre in whatever direction it is held.

**Uses.** It is cut into snuff-boxes, and various other ornaments.

### *Species 30. SPODUMENE.*

**External characters.** Colours, greyish, or greenish white; occurs massive, and in crystals; structure laminated; cleavage parallel to the sides, and shorter diagonal of a rhombic prism; lustre shining, and somewhat pearly; translucent; scratches glass; cross fracture uneven and splintery: sp. gr. 3.19.

**Chemical characters.** Exfoliates a little, and then melts into a nearly limpid glass.

**Composition.** Silica 64.4; alumina 24.4; potash 5; lime 3; oxide of iron 2.2.—*Vauquelin*.

**Distinctive characters.** From adularia, which it most resembles, it differs in the shape of its rhomboidal fragments, and in not emitting the peculiar moon-stone reflections. It is harder than carbonate of lime. Zoisite is commonly of a darker colour, and melts into a porous glass. It is harder than ichthyophthalmite, which separates into flakes in nitric acid.

**Localities.** Utö, in Sweden, in a matrix of red felspar, quartz, and mica. Tyrol, in a granite rock.

U. S. Goshen, Chester, Conway, Lancaster, and Sterling, Mass. At Goshen, it is abundant.—*Robinson*. At Sterling, it fills the place of felspar in a granite rock.—*Silliman*.

### *Species 31. CLEAVELANDITE.\**

**External characters.** Colours, white, greyish white, bluish,

\* In honour of Prof. Cleaveland, of Bowdoin University, Maine.

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What does lepidolite most resemble?—What use is made of lepidolite?—What are the colours of spodumene?—How does spodumene differ from adularia?—What are the colours of cleavelandite?

reddish, or red; occurs massive and crystallized in rhombic tabular crystals, of which the lateral edges are sometimes beveled; crystals often aggregated, so as to present stellated groups; structure laminated; cleavage perfect in two directions; texture of the massive, approaching fibrous, being composed of slender crystals, diverging in rows from straight or curved lines, and producing a feathery aspect; translucent or semi-transparent; scratches glass: sp. gr. 2.50.

According to Phillips, some specimens afford distinct cleavage parallel to all the planes of a doubly oblique prism, yielding to the reflective goniometer, in one direction, alternate angles of  $93^{\circ} 30'$ , and  $86^{\circ} 30'$ , in another direction,  $119^{\circ} 30'$ , and  $60^{\circ} 30'$ , and in another of  $115^{\circ} 65'$ .

*Chemical characters.* Fusible into a white translucent mass.

*Composition.* Silica 70.7; alumina 19.8; soda 9.0; lime 2; oxide of manganese 0.1.—*Stromeyer.*

Mr. Levy, (Ann. Phil.) has examined Cleavelandite with much attention. Its primitive form he finds, as the result of such observations, to differ from that of felspar.

The primitive of the present species is a *doubly oblique prism*, while that of felspar is an *oblique rhombic prism*. These forms are incompatible, notwithstanding their great analogy. The two species very nearly resemble each other, in every respect, and often occur in the same specimen. Cleavelandite, however, Mr. Levy observes, has a certain brilliancy which does not belong to felspar. On re-examination of many specimens, heretofore considered felspar, they have been found to be Cleavelandite, either entirely, or in part. Mr. Levy, indeed, considers the varieties of the present species, to be at least as numerous as those of felspar.

*Localities.* Mr. Turner, of Edinburgh, from whose collection Mr. Levy has made the above observations, has specimens from Dauphiny, St. Gothard, Tyrol, Piedmont, Baveno, Ibla, Vesuvius, Saxony, Sweden, Norway, Siberia, Greenland, United States, and South America.

U. S. Haddam, Conn. Chesterfield and Goshen, Mass. At Chesterfield, it contains rubellite, green tourmaline, and diopside.

### *Species 32. SILLIMANITE.\**

*External characters.* Colour, dark grey, inclining to clove

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\* In honour of Benjamin Silliman, LL. D. of Connecticut.

*Where is Cleavelandite found?*

brown; occurs crystallized in four-sided rhomboidal prisms, whose alternate angles are  $106^{\circ} 30'$  and  $73^{\circ} 70'$ ; the inclination of the base to the axis of the prism being  $113^{\circ}$ ; cleavage parallel to the longer diagonal of the prism; cross fracture uneven, splintery; structure lamellar; lustre of the cleavage, brilliant; of the cross fracture, vitreous; translucent on the edges; angles and sides of the crystals often rounded; hardness greater than that of quartz; sometimes scratches topaz; brittle, and reducible to powder: sp. gr. 3.41.

*Chemical characters.* Infusible, even with borax. Insoluble in acids.

*Composition.* Alumine 54.111; silice 42.666; oxide of iron 1.999; water 0.510.—*Bowen.*

*Distinctive characters.* It somewhat resembles zoisite, but the infusibility and great hardness, as well as the crystalline form, and especially the peculiar cleavage of Sillimanite, will distinguish it from this, and perhaps every other mineral.

The analysis of this species, and the quantity of several of its angles, has induced Prof. Mohs, to conclude that it may be a variety of disthene-spar (cyanite.) But we may remark, that minerals composed of entirely different constituents, are found to crystallize under nearly the same angles, and that the hardness and composition of Sillimanite, indicate a distinct species. The varieties of cyanite yield to the knife, while the present species scratches quartz, and even topaz. Saussure and Laugier, both found cyanite to contain lime. Saussure found, also 2.30, of magnesia. Klaproth found the same mineral to contain a little potash, neither of which belong to Sillimanite.

*Locality.* Saybrook, Conn. in a vein of quartz, penetrating gneiss.

## CLASS VI.

### NATIVE METALS AND METALIFEROUS MINERALS.

This class includes the native metals, together with the ores, or metals combined with other substances, as oxygen, sulphur, or acids.

In some instances, the quantity of metal does not amount to more than one third of the whole weight of the ore, with which

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What are the colours and chemical characters of Sillimanite?—What are the distinctive characters of Sillimanite?—Where is this mineral found?—What substances are included in the sixth class?

it is arranged, the remainder being either some other metallic substance, or clay, sulphur, or silex, &c.

*Genus 1. PLATINA.*

This metal is found in its native state, and also combined with the metals, iridium, palladium, and rhodium.

*Species 1. NATIVE PLATINA.*

*External characters.* Colour, steel grey, approaching to silver white; occurs in grains, seldom exceeding the size of a pea; hardness nearly equal to that of iron; malleable, and may, like iron, be welded; structure sometimes lamellar; but more often not obvious; streak unchanged: sp. gr. 17.33.

*Chemical characters.* Infusible by the blowpipe. By the compound blowpipe, slowly fusible. Soluble in aqua regia only. Not oxidated by exposure to the air.

Nothing is known of the geological situation of this metal, it being found only in small grains in alluvial deposits.

*Localities.* South America, and St. Domingo, but chiefly in the former, where it occurs with zircon, iron ore, and native gold.

Native platina is not perfectly pure, but is mixed with the metals palladium, iridium, and rhodium, together with a little iron.

In a single instance, a mass of platina has been found weighing 1lb. 9oz. 1dr. Its diameter is about two inches, and its shape nearly round. It was found in Choco, South America, and is preserved in the royal museum at Madrid.—*Phillips.*

*Uses.* The infusibility of this metal and its insolubility in most of the acids, renders it extremely valuable in the construction of many useful instruments. In chemistry it is used for spoons, forceps, evaporating dishes, &c. It is also employed in the construction of philosophical instruments, for naval uses, for the covering of other metals to prevent their rusting, for painting porcelain ware, &c.

*Genus 2. GOLD.*

Gold, like platina, is found only in the native state, though often alloyed with other metals.

*Species 1. NATIVE GOLD.*

*External characters.* Colour, golden, or orange yellow, passing into greyish yellow; occurs massive, capillary, amor-

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What are the states in which platina is found?—What are the uses of platina?—In what state is gold found?

phous, dendritic, and crystallized, in cubes, and octohedrons, with various modifications; fracture hackly; lustre metallic; soft and malleable: sp. gr. 14.85 to 19.25.

Fig. 138.

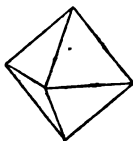


Fig. 138. The octohedron.

Fig. 139.



Fig. 139. The same with the edges truncated.

Fig. 140.

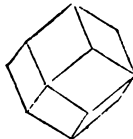


Fig. 140. The rhombic dodecahedron.

These are some of the common forms under which crystallized gold appears; but in many instances the crystals are very irregular, and their geometrical forms difficult to determine. The crystals are generally minute.

**Chemical characters.** It is soluble in nitro-muriatic acid, which solution will tinge the skin of an indelible purple. Fusible with the blow-pipe.

**Distinctive characters.** The malleability of native gold will distinguish it from iron and copper pyrites, and from yellow mica, for each of which it is often foolishly mistaken.

Gold is found in rocks, and in alluvial soils. The rocks, according to Kirwan, in which it most often occurs, are granite, or quartz, slate, hornstone, sandstone, and limestone. It also occurs in veins of iron ore, antimony ore, barytes, blende, &c.

The gold of commerce is, however, almost exclusively found in alluvial deposits, where it occurs in small particles, or grains called *gold dust*.

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What are the crystalline forms of native gold?—What are the distinctive characters of native gold?

According to Mawe, the gold mines of Brazil and Africa, are entirely on the surface, the gold being separated from the sand and gravel, among which it is found, by the simple act of washing.

In Brazil, alone, according to the same author, above twenty tons weight of gold are annually procured, which forms a large share of the circulating medium of Europe.

In Africa, gold dust is an article of commerce, and considerable quantities are exposed for sale, or to exchange for commodities.

The gold of Africa is often adulterated with those varieties of pyrites, which are nearest its colour, and also with brass filings.

This fraud might easily be detected, by throwing the dust into nitric acid, which would dissolve the other substances, leaving the gold untouched.

Gold is found in greater or less abundance, in almost every part of the globe. Jameson observes, that although in comparison with iron, gold occurs in very small quantities, yet it is nearly as widely distributed in nature.

In some rare instances, considerable masses of gold have been found. In 1730 a mass was found in Peru weighing 45 pounds. In Paraguay, several masses are said to have occurred weighing from 20 to 50 pounds. Cleaveland mentions a mass found on Meadow Creek, N. Carolina, which weighed 28 pounds, and Phillips mentions one which occurred in Wicklow, Ireland, weighing 22 ounces.

In the viceroyalty of La Plata, in South America, there are thirty gold mines, or workings.

The mines of Hungary are said to be the most valuable in Europe.

The gold mines of the United States, are confined to the state of North Carolina. According to the statement of Prof. Olmsted (Sill. Jour. vol. 9), the gold country is spread over a space of not less than a thousand square miles, in that state.

*Reed's Mine*, in Cabarras County, where the large mass above mentioned was found, has also afforded many smaller pieces weighing from four to six hundred penny weights.

*Anson Mine*, is situated in the county of Anson, on the wa-

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In what foreign countries is gold found?—What has been the weight of some masses of native gold?—Where has gold been found in this country?



ness of Richardson's creek. This locality was discovered three years since.

*Parter's Mine*, is situated on a small stream, near the Yal-  
kan river.

These three mines are regularly wrought, by making excavations a few feet below the surface, and washing the earth in a manner similar to the process used in South America for the same purpose. The prevailing rock in the gold country is syenite. The country is of a diluvial formation, consisting of drift and sand, generally barren and the inhabitants poor.

It is not easy, observes Prof. Oimsted, to ascertain the precise amount of gold which these mines have afforded, as it is sent to merchants and others, in small quantities, by individuals.

In 1838, the mine of the United States had received to the amount of thirty-nine thousand six hundred eighty-nine dollars in this gold.

### GENUS 3. MERCURY.

Mercury is found native, also combined with sulphur, forming a sulphuret of mercury: with muriatic acid forming a muriate of mercury, and with silver, forming a native amalgam.

#### SPECIES 1. NATIVE MERCURY.

*External Characters.* Colour, silver white: occurs in small quantities, perfectly fluid: feels cold to the touch; lustre metallic sp. gr. 13.

*Chemical Characters.* Becomes volatile when heated, and free of all white vapour.

*Composition.* Mercury, nearly or quite pure.

It is found in small quantities among the ores of mercury. In India, it occurs in limestone and sandstone.

#### SPECIES 2. NATIVE AMALGAM.

*External Characters.* Colour, silver white, or greyish, often tarnished externally: occurs massive lamelliform, in masses and in crystals: form the octohedron, and rhombic dodecahedron: fracture flat conchoidal: lustre shining; sometimes semi-fluid: cleavage none; whitens the surface of polished copper, when rubbed on it: sp. gr. 10.5.

*Chemical Characters.* Before the blowpipe the mercury runs off in white smoke, leaving a globule of pure silver.

*Composition.* Mercury 64; silver 36.—*Klaproth.*

What are the states in which mercury is found?—How is native mercury known?—What is native amalgam?

*Distinctive character.* Its want of ductility will distinguish it from native silver.

*Localities.* Hungary, Siberia, and Sweden. It is found with native mercury, and cinnabar.

**Species 3. SULPHURET OF MERCURY. CINNABAR.**

*External characters.* Colour, scarlet or carmine, passing into cochineal red, and lead grey; occurs massive and crystallized in acute rhomboids, variously modified; translucent, or opaque; streak scarlet red; lustre adamantine, inclining to metallic; fracture granular or fibrous: sp. gr. 8.

It sometimes occurs in thin plates, or tabular crystals, and rarely in imitative shapes.

*Chemical characters.* It is volatile before the blowpipe, with the odour of sulphur.

*Composition.* Mercury 84.5; sulphur 14.75.—*Klaproth.*

*Distinctive characters.* From red silver ore, sulphuret of arsenic, red oxide of copper, and arseniate of cobalt, it is distinguished by entirely disappearing before the blowpipe, without the odour of garlic, or without leaving a metallic globule.

**Variety 1. FIBROUS CINNABAR.**

*External characters.* Colour, scarlet red, often with a tinge of yellow; occurs massive; structure fibrous; lustre shining silky; soils the fingers; often invests other minerals.

*Slaty Cinnabar.* This variety scarcely differs from the others, except in possessing irregular smooth faces, having a slaty appearance when broken.

*Localities.* Upper Carinthia, in gneiss. Transylvania, in grey wacke. Its most important repositories are Idria, in Carniola, and Almandin, in Spain. At Idria the mine has been wrought several centuries, and is now many hundred feet under the surface of the earth. A great proportion of the mercury of commerce is obtained from this locality. It occurs in beds of bituminous shale, associated with black mineral resin, grey sandstone, and limestone. The product of this mine has been chiefly sold to Spain, by a stipulation between the German and Spanish governments.

The mines of Almandin occur in a mountain clay-slate, and shale, and have been worked more than two thousand years.

In South America, there are several quick-silver mines, but

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What is the colour of native cinnabar?—How is native amalgam distinguished from other minerals?

the quantity of metal which they produce is small, when compared with those already mentioned.

U. S. On the borders of the lakes Huron, Michigan, St. Clair, and Erie, and at the mouth of Vermillion river, cinnabar occurs in the form of a dark red sand, which, according to Mr. Stickney, yields about 60 per cent. of mercury.

*Mode of obtaining Mercury from the Cinnabar.* The cinnabar being mixed with iron filings, or lime; and placed in retorts; on the application of heat, the sulphur unites with the iron filings or lime, while the mercury being thus disengaged, is distilled over in its pure state.

*Uses.* A great proportion of the mercury of commerce is employed for the extraction of silver from its ores by amalgamation. According to Humboldt, the quantity employed in South America for this purpose amounts to about twenty-five thousand quintals annually.

Mercury is also used in the construction of two of the most important among philosophical instruments, the barometer and thermometer; when united with tin foil, it forms the amalgam placed over the backs of looking glasses. It is also used in the process of gilding, and in medicine it is the basis of several preparations of the highest value, and for which there is no substitute.

#### *Species 4.* MURIATE OF MERCURY.

*External characters.* Colours, greyish white, yellowish white, and ash grey; occurs massive and crystallized, in four-sided prisms, terminated by four-sided pyramids; with rhombic faces, also in crystalline crusts; translucent; streak white; crystals very small; lustre adamantine; fracture conchoidal; yields to the knife: sp. gr. 6.4.

*Chemical character.* Volatile before the blow pipe.

*Composition.* Oxide of mercury 88.48; muriatic acid 11.52.—*Mohs.*

*Distinctive characters.* The muriate of silver which it most resembles, is soft, and leaves a globule of the metal under the blow pipe.

*Localities.* Idria, in Germany, and Almandin, in Spain, in cavities of sandstone, or clay, with cinnabar.

#### *Genus 4.*—SILVER.

Silver is found native, also combined with sulphur, and muriatic acid, forming sulphuret and muriate of silver. It like-

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How is mercury extracted from cinnabar?—What are the chief uses of mercury?—What is the composition of muriate of mercury?

wise exists in the metallic state, combined or mixed with several other metals.

*Species 1. NATIVE SILVER.*

*External characters.* Colour, silver white, often tarnished grey or reddish; occurs dentiform capillary, ramose, massive, reticulated, and in plates and spangles; also crystallized in cubes and octohedrons: sp. gr. 10 to 10.5.

*Chemical characters.* Fusible into a globule. Soluble in nitric acid, forming a solution which tinges the skin indelible black.

*Composition.* Silver, with a little iron, antimony, copper, or arsenic.

*Distinctive characters.* Its colour and malleability, will always distinguish it.

It is found in primitive, and secondary rocks, with the ores of silver, copper, cobalt, &c.

*Localities.* Saxony, and Suabia, in gneiss and mica slate. Bohemia, Norway, Ireland. In several places in England, and in many of the mines of South America.

U. S. Huntington, Conn. with native bismuth. Near Portsmouth, N. H. a single mass has been found. Near Sing Sing, N. Y. in a small vein.

Native silver often occurs penetrating crystals, or amorphous pieces of common quartz. These, when the quartz is transparent, are sometimes cut into various shapes, and polished as cabinet specimens, or curiosities, and are often very beautiful.

In several instances, large masses of native silver have been found. Thus many years since, a mass occurred near Freyberg, in Saxony, weighing 100lb. 1qr. Another mass was found in the mine of Konsberg, which weighed 560lb; and Jameson mentions a block of the same metal discovered in the mine of Schneeberg, in Saxony, which was so large, that Duke Albert descended into the mine and made use of it as a dinner table. This huge mass, when smelted, produced four hundred centners, (a centner being one hundred and ten pounds,) of pure silver.

*Species 2. ANTIMONIAL SILVER.*

*External characters.* Colour, silver or tin white; occurs massive, in grains, and in hexahedral prisms, or cylinders;

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What are the substances with which silver is found combined?—What is native silver?—How may native silver be distinguished?—What is said of large masses of native silver?

also in curved laminæ ; lustre metallic ; yields to the knife ; fracture conchoidal ; not malleable : sp. gr. 9 to 10.

*Chemical characters.* Fusible, with the emission of antimonial vapour, into a globule of silver.

*Composition.* Silver 84 ; antimony 14.—*Klaproth.*

*Distinctive characters.* It is distinguished from native silver by its want of ductility, and the antimonial vapour, under the blowpipe ; from arsenical iron, and arsenical cobalt, by its want of the garlic odour, when heated, and from white cobalt ore by not giving a blue globule with borax.

It is found in granite and clay-slate, associated with the other ores of silver.

*Localities.* Spain, Suabia, the Hartz, Allemont, in France. It is a rare mineral.

#### *Species 4.* SULPHURET OF SILVER.

*External characters.* Colour, dark lead grey, often with an iridescent tarnish ; occurs in cubes, and octohedrons ; also reticulated, ramose, lamelliform, amorphous, and in plates ; lustre metallic ; cleavage imperfect ; fracture flat conchoidal ; malleable ; easily sectile : sp. gr. 7.

*Chemical characters.* Fusible with intumescence, and odour of sulphur, leaving a globule of silver.

*Composition.* Silver 85 ; sulphur 15.—*Klaproth.*

*Distinctive characters.* From native silver, it may be known by its less specific gravity and its sulphurous odour under the blow pipe.

It occurs in primitive and secondary rocks, and is associated with the other ores of silver.

*Localities.* Freyberg, Bohemia, many places in Peru, and Mexico, the Hartz, Cornwall, and other places in England, and in Lower Austria.

U. S. Livingston's lead mine, Columbia county, N. Y.

The present species is found in almost every silver mine, in greater or less quantity, and is an important ore for the extraction of silver.

#### *Variety 2.* BRITTLE SULPHURET OF SILVER.

*External characters.* Colours, dark lead grey, or bluish grey, passing into iron black ; occurs massive and disseminated ; also in hexahedral prisms, with truncated terminal edges, and so short as to become lenticular ; lustre metallic,

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What is the composition of antimonial silver ?—What is the colour of sulphuret of silver ?—What is the composition of sulphuret of silver ?—Is this ore of any importance ?

or dull; structure foliated; crystals mostly intercept each other; soft and brittle; fracture conchoidal: sp. gr. 7.

*Chemical characters.* Fusible with the evaporation of sulphur, arsenic, and antimony, into a globule of silver, surrounded by a slag. Soluble in nitric acid.

*Composition.* Silver 66.5; antimony 10; iron 5; sulphur 12; arsenic and copper 5.—*Klaproth.*

*Distinctive characters.* It differs from sulphuret of silver, in its want of malleability, and from arsenico-antimonial silver, by its darker colour and brittleness.

It is found in primitive rocks with the other ores of silver, and is a rich ore.

*Localities.* Near Freyberg, in Saxony. Bohemia, and Hungary.

**Species 5. SULPHURETTED ANTIMONIAL SILVER. RED SILVER.**

*External characters.* Colour, red, of various shades, passing into lead grey, and greyish black; powder crimson red; occurs in masses and grains, also dendritic, membranous, capillary, and crystallized, in hexahedral prisms, terminated by hexahedral pyramids, variously modified by truncation; also in double six-sided pyramids, with the edges replaced; lustre metallic adamantine; crystals often striated; structure imperfectly foliated; yields to the knife; translucent, opaque: sp. gr. 5.20 to 6.68.

Fig. 141.

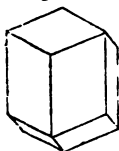


Fig. 141. A six-sided prism, terminated by three sided pyramids, the faces of which stand alternately on the lateral edges of the prism.

Fig. 142.

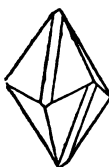


Fig. 142. A double six-sided pyramid, with the acute angles truncated.

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What is the colour of sulphuretted antimonial silver?—What are the crystalline forms of sulphuretted antimonial silver?

## ~~INTRODUCTION TO~~

A dodecahedron, or double six-sided py-  
ramid, the summits truncated, or replaced by three

*Characters.* Fusible with antimonial fumes, into silver.

*Composition.* Silver 80.3: sulphur 14.7: ~~arsenic~~.

*Preparation.* From sulphuret of arsenic, it dif-  
fers in being a heavier specific gravity, and in leaving a  
residue of sulphur. Sulphuret of mercury is entirely dissipa-  
ted by heat. The sulphuret of silver is malleable.  
The silver, after being submitted to the blow pipe  
test, and the oxide of copper is easily reduced to  
metallic silver by the blow pipe.

*Localities.* Found in mica-slate, and porphyry.  
In the States of Sardinia, Transylvania, Spain, Italy,  
Mexico, and Peru.

*Properties.* The extraction of silver  
from the ore is the object of the ASSAY OF SILVER.

*Color.* Colour, grey, or blackish grey: oc-  
casionally crystallized: fracture uneven; texture  
granular: shining metallic: brittle.

*Characters.* Fusible, and easily reduced. Efflu-  
escence.

*Composition.* Silver 74.3: arsenic acid 12; oxide of an-  
timony 13.5.

*Localities.* Wittenberg, Saxony, in sulphate of barytes.  
In the States of Saxony.

*Properties.* The extraction of silver. **HORN SILVER.**

*Color.* Colour, pearl grey, greenish or red-  
dish: sometimes white and brown; occurs  
in small, sometimes reniform, amorphous, and  
sometimes radiated, and acicular prisms; vari-  
ously shining and waxy: soft, yields to  
the blow pipe: becomes brown  
by heat.

What is the composition?—What is the compo-

**Chemical characters.** Fusible in the flame of a candle. Under the blow pipe, emits muriatic acid fumes, and is reduced to a globule of silver. Rubbed on moistened zinc, it leaves a film of silver.

**Composition.** Muriate of silver 88.7; oxide of iron 6; alumine 1.75; sulphuric acid 0.25.—*Klaproth*.

**Distinctive characters.** The muriate of mercury which it resembles, is entirely volatile before the blow pipe. The present species leaves a silver globule.

It is found in primitive rocks, with the other ores of silver.

**Localities.** Friberg, in Saxony. Hungary, in several mines, South America, Cornwall, England, Siberia, Spain, and France.

It is a good ore for the extraction of silver.

**Subspecies 1. ARGILLACEOUS MURIATE OF SILVER.**

**External characters.** Colours, brownish white, greenish white, or pale green, externally bluish or brownish; occurs massive, and coating other minerals; fracture earthy; opaque; soft, sometimes nearly fluid.

**Chemical characters.** It feebly agglutinates under the blow pipe, while minute globules of silver flow from the mass.

**Composition.** Silver 24.64; muriatic acid 8.28; alumine with a trace of copper 67.08.—*Klaproth*.

**Locality.** Andreasberg, in the Hartz.

Silver was probably unknown to the antediluvians, as it is nowhere mentioned in the writings of Moses, who only speaks of brass and iron, among the metals. In the time of Abraham, it appears to have been an article of common traffic, in the form of bars and ingots.—*Calmet*.

According to Humboldt, the late annual product of the South American silver mines may be estimated at more than 32 millions of dollars.

According to Shaw, the quantity of gold and silver extracted from the American mines, from 1492 to 1803, has been equal in value to 5,706,700,000 dollars, of which immense sum it is estimated, that including the booty which the Spaniards took from the natives, about 5,445,000,000 was carried to Europe, making a yearly average of 17 millions and a half for 311 years.

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What are the chemical characters of muriate of silver?—What is the use of muriate of silver?—At what period of the world did silver come into use?—What is said of the quantity of gold and silver which has been raised from the mines of South America?



The annual importation of these metals from South America to Europe has been constantly increasing. From 1492 to 1500, the yearly importation did not exceed 250,000 dollars. From 1500 to 1545, it amounted to 3,000,000. From 1545 to 1600, it was 11,000,000. From 1600 to 1700, to 16,000,000. From 1700 to 1750, 22,000,000 and a half. And lastly, from 1750 to 1803, the annual amount was 35,300,000 dollars.

Humboldt calculates the weight of silver raised from these mines in three centuries, to have been 316 millions of pounds.

#### Genus 5. COPPER.

Copper is found native, also combined with sulphur, with oxygen, carbonic acid, arsenic acid, sulphuric acid, muriatic acid, and with several of the metals. Its ores are very numerous, and many of them highly beautiful and interesting.

*Uses.* Copper, next to iron, is probably the most indispensable metal, to the wants of man. Its uses are various and generally known. *Brass*, a compound, in universal use, is composed of copper and zinc. Bell metal, bronze, pinchbeck, speculum metal, and many other useful compounds, are alloys of copper, with various other metals. Its salts and oxides are employed as paints, in colouring, and enameling, &c.

#### *Species* 1. NATIVE COPPER.

*External characters.* Colour, copper red, tarnished externally brownish black; occurs dendritic, capillary, reniform, and amorphous; also crystallized in cubes, and octohedrons, variously modified by truncation; malleable: sp. gr. 8.5.

*Chemical characters.* Fusible. Soluble in acids, forming salts, which give a beautiful blue when mixed with liquid ammonia.

*Composition.* Copper, nearly or quite pure.

It is found in the veins of primitive and secondary rocks.

*Localities.* Siberia, Suabia, Saxony, Norway, and in many of the copper mines in England.

U. S. Monroe county, Illinois. Near Lake Superior, North West Territory, a mass was found weighing by estimation 2,200lbs—*Schoolcraft*. Orange county, Vir. Blue ridge, Md. Adams county, Penn. Woodbridge, N. J. Hamden hills, Conn. a mass was found weighing about 90lbs. Also 12 miles from New Haven, another mass was found of 6lbs. weight.—*Silliman*.

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What are the substances with which copper is found combined?—What is the appearance of native copper?—What is said of large masses of native copper?

**Species 2. SULPHURET OF COPPER.**

**External characters.** Colour, blackish lead grey, sometimes iridescent; internally lead grey, or tin white; occurs massive, and in pseudomorphous crystals; also crystallized in long tabular six-sided prisms, variously modified, and in obtuse, and acute double six-sided pyramids, with the summits often truncated; structure perfectly lamellar; cleavage easy, with brilliant faces; easily broken into grains; crystals small and grouped; the massive sectile, passing into hard; fracture conchoidal: sp. gr. about 5.

**Chemical characters.** Fusible with the odour of sulphur, into a greyish metallic globule. Soluble in hot nitric acid.

**Composition.** Copper 76.50; sulphur 22; iron 0.50.—*Klaproth.*

**Distinctive characters.** Grey copper decrepitates under the blow pipe, and is harder than the present species. Grey antimonial copper gives out the fumes of antimony. Red oxide of copper is easily known from it, by the difference of colour.

**Species 3. FERRUGINOUS SULPHURET OF COPPER. COPPER PYRITES.**

**External characters.** Colours, golden, or brass yellow, often with an external iridescent tarnish; occurs dendritic, stalactical, amorphous, in concretions, and crystallized; form, the tetrahedron, with the solid angles often truncated, also the dodecahedron, formed by raising a three-sided pyramid, on the faces of the tetrahedron; lustre shining, and metallic; structure lamellar; cleavage parallel to the faces of the octohedron; faces brilliant; crystals small and seldom perfect; yields to the knife: sp. gr. 4.3.

**Chemical characters.** Fusible into a black globule, which on continuing the heat becomes magnetic. Tinges borax green.

**Composition.** Copper 40 to 35.5; iron 40 to 33; sulphur 20 to 35.

Different specimens seldom yield the same proportions of these ingredients. It often contains a portion of silice.

**Distinctive characters.** It resembles iron pyrites, but this is commonly of a bronze yellow, and does not tinge borax green. Native bismuth is laminated, and melts with great

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What is the colour of sulphuret of copper?—What is the composition of sulphuret of copper?—What is the colour of copper pyrites?—How may this ore be distinguished?—What is the composition of copper pyrites?

ease into a bright globule, that of the present species being black. Native gold is malleable.

It is found in primitive and secondary rocks, and is one of the most common and abundant ores of copper.

*Localities.* Spain, Bohemia, Siberia, Silesia, Norway, Japan, Cornwall, and many other places in England.

U. S. Perkiomen lead mine, Penn. Also, in Chester, Delaware county. On the Hudson, N. Y. in many places. Cheshire, Simsbury, Farmington, and Granby, Conn. Woburn, Brighton, and Cambridge, Mass.

It is a valuable ore for the extraction of copper, and from it a great proportion of that used in commerce, is obtained.

*Variety 1. PURPLE COPPER.*

*External characters.* Colours, blue, or yellow, sometimes intermediate between bronze yellow, and copper red ; iridescent ; occurs massive, and crystallized in the form of cubes with curvilinear faces, and truncated angles ; also in plates which are sometimes hexagonal ; structure imperfectly lamellar ; cleavage parallel to the planes of the regular octohedron ; soft ; easily frangible ; lustre metallic ; subject to tarnish : sp. gr. 5.

*Chemical characters.* Fusible into a globule which is magnetic. Effervesces with nitric acid.

*Composition.* Copper 58 ; iron 18 ; sulphur 19 ; oxygen 5.—*Klaproth.*

*Distinctive characters.* Its greater specific gravity, and its variegated colours, will distinguish it from ferruginous sulphuret of copper.

It is found in primitive and secondary rocks, with the other ores of copper.

*Localities.* Arendal, Cornwall, Switzerland, Saxony, &c.

*Species 4. GREY COPPER.*

*External characters.* Colour, steel grey, passing into iron black ; streak brownish ; occurs amorphous, disseminated, and crystallized in tetrahedrons, of which Haüy has enumerated twelve modifications ; lustre glistening and metallic ; brittle ; crystals small and grouped : sp. gr. about 5.

Fig. 144.

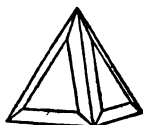


Fig. 144. The tetrahedron, with the edges bevelled or replaced by two planes.

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*Of what use is this ore ?—What is said of purple copper ?*

Fig. 145.



Fig. 146.



Fig. 145. The same, with the edges, and solid angles truncated.

Fig. 146. The pyramidal dodecahedron, with curved faces.

*Chemical characters.* Fusible, but not easily reduced to metallic state.

*Composition.* Copper 52; iron 23; sulphur 14.—*Chenevix.*

*Distinctive characters.* Specular oxide of iron is magnetic; arsenical iron is harder than grey copper, and gives out arsenical fumes when heated.

It is found with the other ores of copper, and with those of iron in primitive and secondary rocks.

*Localities.* Freiberg, in Saxony. Gomor, in Hungary. Several places in the Tyrol. Spain, Scotland, England, &c.

#### *Species 4. TENNANTITE.*

*External characters.* Colour, lead grey, passing into black-grey; occurs crystallized in the form of rhombic dodecahedrons; also in cubes and regular octohedrons; cleavage perfect; structure foliated; lustre metallic; streak reddish grey; brittle: sp. gr. 4.37.

*Chemical characters.* Burns with a bluish flame, and then its arsenical vapours, leaving a black magnetic scoria.

*Composition.* Copper 45.32; arsenic 11.84; iron 9.26; sulphur 28.74; siliceous 5.—*Phillips.*

*Locality.* Cornwall, Eng. in several of the copper mines.

#### *Variety 1. WHITE COPPER.*

*External characters.* Colours, internally nearly silver white, sometimes with a tinge of yellow; soon tarnishes; lustre metallic and glistening; occurs massive and disseminated; cleaves to the knife; fracture fine grained, uneven; brittle: sp. gr. 4.5.

*Chemical characters.* Fusible, with arsenical vapours, into arsenical slag.

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What is the colour of grey copper?—What are crystalline forms of grey copper?—What is Tennantite?

**Composition.** Copper 40 ; the remainder being iron, arsenic and sulphur.—*Vauquelin*.

**Localities.** Cornwall, with other copper ores.

U. S. Fairfield, Conn. in compact masses, colour metallic : sp. gr. 5.—*Silliman*.

**Species 5. RED OXIDE OF COPPER. OCTOHEDRAL COPPER.**

**External characters.** Colour, red, of various shades, as deep cochineal red, greyish red, and pure cochineal red ; occurs amorphous and crystallized in regular octohedrons, and cubes, variously modified by truncation, and bevelment ; structure lamellar, but rarely visible ; cleavage parallel to the planes of the octohedron ; lustre metallic adamantine ; fracture conchoidal, uneven ; translucent ; yields to the knife ; brittle ; powder vermillion red : sp. gr. 4 to 5.9.

Fig. 147.

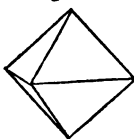


Fig. 147. The regular octohedron, the primary form.

Fig. 148.

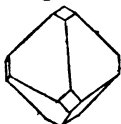


Fig. 148. The same, with all the solid angles truncated, producing quadrangular planes.

Fig. 149.

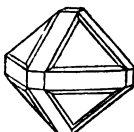


Fig. 149. The octohedron, with its edges and solid angles truncated, the angles produced by the truncation being slightly bevelled, forming three planes.

Fig. 150.



Fig. 150. The rhombic dodecahedron, with all its edges and solid angles slightly truncated.

According to Phillips, this mineral occurs under 100 secondary forms.

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What is the composition of white copper ?—What are the crystalline forms of octohedral copper ?—How many secondary forms of this ore are said to exist ?

**Chemical characters.** Fusible, and easily reduced to the metallic state. Dissolves with effervescence, in nitric acid; in muriatic acid, without effervescence.

**Composition.** Copper 91; oxygen 9.—*Klaproth*.

Copper 88.5; oxygen 11.5.—*Chenevix*.

**Distinctive characters.** The red colour of this species, and its effervescence in nitric acid, will distinguish it from red silver ore, which does not effervesce, and from the sulphurets of copper, which are not red. Cinnabar does not effervesce, and is volatile by the blowpipe.

Oxide of copper is found in primitive, and secondary rocks, associated with the other ores of copper.

It is found in small quantities, but its localities are numerous.

#### *Species 6.* BLUE CARBONATE OF COPPER.

**External characters.** Colour, blue, of different shades, as azure or indigo blue; occurs massive, stalactical, encrusting, disseminated, and crystallized; primitive form, the oblique rhomboidal prism; secondary forms an octohedral prism, with dihedral summits, and an oblique four-sided prism, truncated on its two opposite lateral edges, and terminated by four-sided summits; fracture imperfectly foliated, usually presenting broad diverging fibres.

**Chemical characters.** Infusible without addition; with borax, gives a green glass, and yields a metallic globule. Dissolves with effervescence in nitric acid.

**Composition.** Oxide of copper 70; carbonic acid 24; water 6.—*Klaproth*.

**Distinctive characters.** The sulphate of copper, which it may resemble, is soluble in water. Azure phosphate of iron becomes magnetic under the blowpipe.

Some specimens of implanted crystals present brilliant shining faces in every position, and being of an intense rich blue, are peculiarly striking and beautiful.

It is found in primitive and secondary mountains.

**Localities.** Chili, Bohemia, the Hartz. Most of the copper mines in England. Chessy, in France. Uralian mountains, &c.

U. S. Perkiomen lead mine, Penn. Schuyler's mines, N. J. Hartford, Conn.

Jameson remarks, that this species is not only used as an

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What is the composition of this ore?—What is the composition of blue carbonate of copper?—What is the use of blue carbonate of copper?

ore of copper, but also as a pigment, called *mountain blue*, of which there is a manufactory in the Tyrol.

*Species 7. GREEN CARBONATE OF COPPER. MALACHITE.*

*External characters.* Colour, emerald, grass, or apple green, also verdigris green; streak and powder, lighter green; occurs tuberoso, globular, reniform, mammillary, and stalactical; also in fibres, and curved folia, and rarely in crystals; form four-sided prisms, generally very minute; and in rhombic prisms; lustre shining, or dull: sp. gr. about 4.

*Chemical characters.* Turns black, but does not melt alone; with borax, gives a dark greenish glass; effervesces with acids, and forms a blue colour with ammonia.

*Composition.* Copper 58; oxygen 12.50; carbonic acid 18; water 11.50.—*Klaproth.*

*Distinctive characters.* From the green oxide of uranium, the green phosphate of lead, and the green muriate of copper, it is distinguished by its effervescence with acids. The green arseniate of copper gives out the garlic odour when heated.

*Variety 1. FIBROUS MALACHITE.*

*External characters.* Colour, green, of various shades; occurs in delicate shining fibres, sometimes radiated, or fasciculated; lustre silky; translucent; very soft; brittle.

It is found incrusting other minerals, particularly ores of copper, in thin layers, composed of radiating, delicate fibres, of a glistening, silky lustre.

According to Jameson, these fibres are regular crystals, of which Estner determined, that some were six-sided prisms, with bevelled edges, others three-sided truncated prisms, &c.

It occurs in small quantities with other ores of copper.

*Localities.* Silesia, Norway, Sweden, Russia, and the several mines in England.

U. S. Schuyler's mines, N. J. Perkiomen lead mine, Penn. Cheshire, Conn. in small, but good specimens.—*Silliman.*

*Variety 2. COMPACT MALACHITE.*

*External characters.* Colours, green, emerald green, passing into apple, verdigris, or grass green; occurs in masses, composed of botryoidal, globular, or reniform concretions, of a fibrous radiating structure, closely compacted together. Sometimes the concretions are concentric lamellar, in one di-

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What is the composition of green carbonate of copper?

rection, and fibrous in another; fracture conchoidal; *opaque*; lustre glistening and silky; aspect often striped.

*Composition.* Oxide of copper, 72.2; carbonic acid 18.5; water 9.3.—*Phillips.*

It occurs with the blue carbonate of copper, and fibrous malachite.

*Localities.* Bohemia, England, Russia, Saxony, Norway, and Siberia.

U. S. Blue Hills, Md. Near Nicholas Gap, Penn. Near Boundbrook, N. J. Greenfield, Mass.

*Uses.* It is ground, and employed as a paint, and is sometimes cut and polished for jewelry. Specimens are sometimes found of considerable size, and are sawn into thin plates, and polished as curiosities, for the covers of boxes, or are worked into vases, &c. These, when polished, display the radiated structure, and silky, changeable lustre of the mineral to great advantage, and are often extremely beautiful.

Jameson remarks, that Patrin saw a slab of green malachite at St. Petersburg, which was thirty-two inches long, and seventeen broad, and was valued at twenty thousand livres.

#### *Species 8. MURIATE OF COPPER.*

*External characters.* Colour, emerald, verdigris, or leek green; also blackish green; streak, pale green; occurs in minute octohedrons, either with wedge-shaped terminations, or variously truncated, or both; also in lamellar masses, and in concretions composed of acicular crystals resembling malachite; structure lamellar; brittle; lustre shining; translucent; crystals often transparent: sp. gr. 3.52 to 4.4.

*Chemical characters.* Communicates bright blue and green colours to the flame of a candle; before the blowpipe gives the muriatic odour, and melts into a globule of copper. Soluble in nitric acid, without effervescence.

*Distinctive characters.* From arseniate of copper, it differs in emitting the muriatic, instead of the garlic odour. From malachite it is known by the same properties, as well as by the peculiar colour it gives to the flame.

*Localities.* Remolinos, in Chili, with carbonate of copper. Peru, with the ores of silver. Vesuvius, in lava.

U. S. Woburn, Brighton, and Medford, Mass.

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What are the uses of compact malachite?—What is the colour of muriate of copper?—What are the chemical characters of muriate of copper?



**Species 9. SULPHATE OF COPPER. BLUE VITRIOL.**

*External characters.* Colour, deep rich blue, and sky blue; artificial crystals, four, six, or eight-sided prisms, often terminated by dihedral summits; native crystals very rare; more commonly occurs stalactical, and pulverulent; taste styptic, and nauseous; when rubbed on moistened, polished iron, leaves a coat of copper.

Sulphate of copper, or blue vitriol, is sometimes found in solution, in the water proceeding from mines of the sulphuret of copper, and from the decomposition of which, it is produced.

*Localities.* Anglesea in England, Wicklow in Ireland, Fahlun in Sweden, near Goslar in Hungary.

At the copper mine of Anglesea, considerable quantities of the metal are obtained by throwing into the water which comes from the mine, waste iron, on which the metallic copper is precipitated.

The blue vitriol of commerce is obtained partly by crystallizing such natural solutions, and partly by lixiviating inferior ores of copper.

*Uses.* Its principal use is in dyeing. It is also employed in medicine.

**Species 10. PHOSPHATE OF COPPER.**

*External characters.* Colours, emerald, verdigris, or blackish green, often darker on the surface; occurs crystallized in rhombic prisms with curvilinear faces, and in octohedrons, often elongated, and terminating in truncated pyramids; crystals very small, and fasciculated or grouped; also it occurs in mammillary, or reniform concretions composed of radiating, or diverging delicate fibres, and in thin plates, opaque; crystals often translucent; lustre resinous, or silky; structure foliated; cleaves in two directions: sp. gr. 4.

*Chemical characters.* Fusible into a brownish globule, which extends itself on the charcoal, and by the addition of a little tallow, is reduced to a small globule of copper. Dissolves without effervescence in nitric acid.

*Composition.* Oxide of copper 68.13; phosphoric acid 30.95.—*Klaproth.*

*Distinctive characters.* Its solubility without effervescence, will distinguish it from malachite, and the effects of the blow-pipe will distinguish it from arseniate of copper, chrysocolla, and muriate of copper.

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*Is the sulphate of copper ever a natural product?—What is the composition of phosphate of copper?*

*Localities.* Hungary, at several places. Cornwall, in England; and near Cologne, in Italy.

*Species 14. ARSENIATE OF COPPER.*

*Variety 1. OCTOHEDRAL ARSENIATE OF COPPER.*

*External characters.* Colours, sky blue, bluish white, greenish white, or verdigris green; streak pale; occurs in obtuse pyramidal octohedrons, composed of two four-sided pyramids joined base to base; crystals small; cleavage parallel to all the planes of an obtuse octohedron; lustre vitreous; translucent, semi-transparent; brittle; not so hard as fluor: sp. gr. 2.88.

Fig. 151.

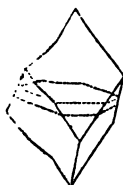


Fig. 151. An obtuse octohedron, or two four-sided pyramids set on a short common base; a form under which this mineral commonly occurs. The crystals are often flattened, so as to become nearly lenticular.

*Chemical characters.* Fusible into a black scoria; with borax, yields a metallic bead of copper. Gives the garlic odour when heated.

*Composition.* Oxide of copper 49; arsenic acid 14; water 35.—Chenevix.

*Distinctive characters.* It differs from malachite, in not efferecing with acids, and in giving the odour of garlic. Green oxide of uranium, is not reduced by the blowpipe. Muriate of copper exhales the muriatic vapour.

*Locality.* Cornwall, in England, with many other varieties of copper ore.

*Variety 2. RHOMBOIDAL ARSENIATE OF COPPER*

*External characters.* Colours, pure green, emerald green, grass green, rarely bluish green, or greenish white; occurs in six-sided tabular crystals, of which the lateral planes are trapeziums; cleavage parallel to all the planes of the rhomboid; structure foliated, with brilliant faces parallel to the broader planes; transparent, translucent; crystals sometimes arranged in rose-like forms, and sometimes form foliated, or tabular masses, which are divisible like those of mica; yields to the knife, or nail: sp. gr. 2.54.

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What is the composition of arseniate of copper?

*Chemical characters.* Fusible into a globule ; with borax, yields a bead of copper.

*Composition.* Oxide of copper 58 ; arsenic acid 21 ; water 21.—*Chenevix.*

*Distinctive characters.* These are similar to those of the variety above, while it may be distinguished from that variety, by the forms of its crystals and foliated structure.

*Localities.* Cornwall, in several of the copper mines.

*Variety 3.* OBLIQUE PRISMATIC ARSENIATE OF COPPER.

*External characters.* Colour, bluish black, or deep black ; occurs in curved lamellar concretions, and more rarely in minute oblique rhombic prisms ; crystals fasciculated, or radiating, and often of a beautiful blue, by transmitted light ; when massive, nearly black ; translucent, or transparent ; yields to the knife : sp. gr. 4.2.

*Chemical characters.* Before the blowpipe, flows like water, and in cooling, crystallizes in plates of a brown colour.

*Composition.* Oxide of copper 54 ; arsenic acid 30 ; water 16.—*Chenevix.*

*Distinctive characters.* Its peculiar chemical characters, and its crystallization on cooling, will distinguish it from substances it most resembles.

*Locality.* Cornwall, with the other varieties of this species.

*Variety 4.* RIGHT PRISMATIC ARSENIATE OF COPPER.

*External characters.* Colours, various shades of olive green, passing into yellowish, brownish, or blackish green ; occurs in prismatic crystals ; cleavage parallel to the planes of a right rhombic prism ; crystals often capillary ; translucent ; opaque ; shapes of the massive, globular, and reniform ; surface drusy ; brittle : sp. gr. 2.28.

*Chemical characters.* Fusible with a kind of deflagration, and by continuing the heat, is reduced ; the globule of copper being covered with a coating of the red oxide. Soluble in nitric acid.

*Composition.* Oxide of copper 50 ; arsenic acid 29 ; water 21.—*Chenevix.*

*Distinctive characters.* The difference between the chemical characters of this variety, and that above, will distinguish them from each other.

*Localities.* Cornwall, and Cumberland, Eng.

*Species 15.* MARTIAL ARSENIATE OF COPPER.

*External characters.* Colours, leek green, olive green,

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What varieties of arseniate of copper are described ?

passing into white; also, pale blue, and yellowish green; streak, white; occurs in reniform masses, composed of minute crystals, and in crystals, the forms of which are right rhombic prisms, terminated by four-sided pyramids; lustre vitreous; harder than calcareous spar; translucent, or transparent; fracture uneven; brittle: sp. gr. 3.16.

*Chemical characters.* Emits an arsenical odour, and melts into a brownish scoria, which acts on the magnet.

*Composition.* Oxide of copper 22.5; oxide of iron 27.5; arsenic acid 33.5; water 12; siliceous 3.—*Chenevix.*

The great copper mine of Fahlun, in Sweden, has been worked to the depth of 1200 feet, and one of the Cornwall copper mines, is 1800 feet deep. In both of these mines, the heat is so great that the miners carry on their labour with little or no clothing, in the coldest season. In the Fahlun mine, according to Dr. Clarke, the heat to a stranger is absolutely intolerable. This high temperature, is in part owing to the fires which are kindled to soften the rock, or break it in pieces, so as to lessen the labour of the miners, and in part to the great depth of the mines, the heat increasing, it is said, in proportion to the descent into the bowels of the earth.

#### Genus 6. LEAD.

The colour of pure lead, is bluish grey, approaching to white, but it soon tarnishes on exposure to the air. Its specific gravity is 11. The ores of this metal are numerous, but with the exception of the sulphuret of lead, they are of no considerable importance to the arts.

Lead is found native, also combined with several of the other metals; with sulphur, with several of the acids, with oxygen, with several of the acidified metals, and with carbonic acid.

*Uses.* The uses to which this metal is applied are numerous and important. In its metallic state, it is employed in the construction of aqueducts; for covering the roofs of houses; for the linings of boilers, for certain uses; in the composition of pewter, &c. Its oxides and salts, are employed as paints; in the composition of glass; in medicine, and in several of the more common arts.

This metal is inert on the living system, but its salts and oxides operate as slow, but certain poisons.

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What is the composition of martial arseniate of copper?—What is said of the copper mines of Sweden and England?—What are the uses of metallic lead?—Is this metal a poison in its metallic state?—In what combination does it become poisonous?

**Species 1. SULPHURET OF LEAD. GALENA.**

**External characters.** Colours, bluish grey, lead grey; externally blackish grey, and sometimes irised; occurs crystallized, amorphous, and reticulated; form the cube, and regular octohedron, with many of their varieties; structure lamellated; cleavage parallel to the planes of the cube, which is its primitive form; lustre of the cleaved surfaces, very brilliant; soft; brittle; opaque; when massive, the structure is granular, and the fracture uneven, flat conchoidal: sp. gr. 7.5.

Fig. 152.



Fig. 152. The regular octohedron, a form next to the cube, under which the present species most commonly appears.

Fig. 153.

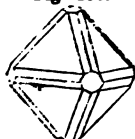


Fig. 153. The octohedron, with its edges bevelled, or replaced by two planes.

Fig. 154.



Fig. 154. The octohedron, with its solid angles deeply truncated, and the edges replaced.

**Chemical characters.** First decrepitates, and then melts with the odour of sulphur, into a globule of lead.

**Composition.** (A mean of 4 specimens.) Lead 67.5; sulphur 17; lime and silex 15.5.—*Vauquelin*.

**Distinctive characters.** Between the sulphuret of lead, and the sulphuret of zinc, there are these distinctions. The lead is reduced to a metallic globule, by the blowpipe, and is fixed; while the zinc being reduced, is soon evaporated. Molybdena is infusible, as is the case with graphite.

**Variety 1. GRANULAR GALENA.**

**External characters.** Colour, the same as in the species; occurs massive, composed of small crystalline grains, irregularly disposed; fracture granular; lustre shining; resembles steel; less apt to tarnish, than the other varieties.

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What is the colour of galena?—What are the distinctive characters of galena?

In other respects, it does not differ from the species.

*Variety 2.* COMPACT GALENA.

*External characters.* Colour, light lead grey; occurs in nodules, or small masses; fracture conchoidal; structure fine grained; texture close, and compact; lustre moderate; often contains silver.

*Variety 3.* SPECULAR GALENA.

*External characters.* Colour, lead grey; occurs in extremely thin coatings, on quartz, and other substances; lustre splendid, with an appearance of polish.

This variety, from its high lustre, is called by the miners, *slickensides*, or *looking-glass lead ore*.

This variety is found chiefly in the Derbyshire lead mines, and Mr. Phillips states the curious circumstance, that when two vein-stones meet, the surface of each being coated with this variety, there is a loud report, or explosion, produced on separating them, the fragments at the same time being projected in various directions.

*Variety 4.* ANTIMONIAL SULPHURET OF LEAD.

*External characters.* Colour, steel grey, passing into dark lead grey, or iron black; occurs amorphous and crystallized, in the form of rectangular prisms, variously modified; or in elongated cubes; crystals grouped; structure lamellar, affording brilliant faces parallel to the planes of a four-sided prism; brittle; lustre strongly metallic; crystals striated on certain faces; soft; yields to the nail: sp. gr. 5.7.

*Chemical characters.* Fusible, with the escape of white antimonial fumes, into a metallic globule, which contains a bead of copper at the centre.

*Composition.* Lead 42.62; antimony 24.23; sulphur 17; copper 12.8; iron 1.2.—*Hatchett*.

*Distinctive characters.* The antimonial fumes, which it emits, and the globule of copper surrounded by a crust of lead which the blowpipe produces, will distinguish this variety.

Sulphuret of lead is found in primitive and secondary mountains, but most frequently in the latter, and particularly in limestone. In granite and limestone, it sometimes constitutes extensive beds, but more often occurs in veins of various dimensions and extent. It is commonly associated with the ores of zinc, copper, and iron, and often with those of silver, a portion of which, it generally contains.

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What are the varieties of galena?—What is the composition of galena?—What are the ores with which galena is associated?

**Localities.** England is a great repository of this ore. According to Phillips, the lead mines of Great Britain, produce annually from 45 to 48,000 tons of smelted lead. This is extracted almost entirely from the sulphuret, the largest proportion of which, is raised from the mines of England.

France also contains its mines of this metal, as well as Savoy, Bohemia, and Spain.

U. S. Perkioenen creek, 23 miles from Philadelphia, Penn. The shaft of this mine is 170 feet deep. Livingston's Manor, Columbia county. Ancram. Shawangunk mountain, and Ulster county, N. Y. One ton from Livingston's mine, is said to have yielded 115 ounces of silver. Huntington, Southington, Middletown, and Bethlehem, Conn. None of these are wrought. Thetford, and Sunderland, Vt. Southampton, and Leverett, Mass. The mine at Southampton has a horizontal entrance through the solid granite of nearly 1000 feet, and is expected ultimately to yield the best ore, in large quantities. Counties of Washington, St. Genivieve, Jefferson, and Madison, Missouri. The number of mines in these counties, according to Schoolcraft, are 45. The ore on an average, yields from 60 to 70 per cent. of metal, and is found in an alluvial deposit. The whole annual product of them, is about 3,000,000 of pounds. This ore is also found in Illinois, Ohio, Indiana, Tennessee, Maryland, Virginia, and in various places in the North-Western Territory.—See *Cleveland's Mineralogy*, and *Robinson's Localities*.

**Species 4. CARBONATE OF LEAD.**

**External characters.** Colours, white, yellowish white, greyish white, and light brown; occurs in tabular crystals, in six-sided prisms, in cuneiform octohedrons, in four-sided prisms, and in double six-sided pyramids, each form being subject to various modifications, by truncation; also massive, compact, in spangles, and pulverulent; fracture uneven; transparent, or translucent; lustre adamantine, passing into resinous; brittle; sectile; refraction double: sp. gr. 6 to 7.23.

Fig. 155.

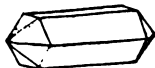


Fig. 155. A six-sided prism, terminated by six-sided pyramids.

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Where are the principal lead mines of this country?—What are the colours of carbonate of lead?

Fig. 156.



Fig. 156. The same figure modified by truncation.

Fig. 157.

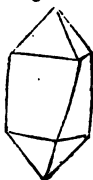


Fig. 157. A four-sided prism, with curved faces, terminated by four-sided pyramids, another common form.

*Chemical characters.* Decrepitates, becomes yellow, then red, and is immediately reduced to a globule of lead. Effervesces with muriatic acid.

*Composition.* Oxide of lead 82; carbonic acid 16; water 2.—*Klaproth.*

*Distinctive characters.* Its high specific gravity, will distinguish it from carbonate of lime, and its effervescence from the sulphates of barytes and strontian. Its reduction to the metallic state, will indeed distinguish it from every mineral which it resembles.

Crystals of the carbonate of lead, are generally grouped, or aggregated, or intersect each other in such a manner, as to make it difficult to determine their forms.

They are subject to decomposition, and in consequence, become grey and opaque.

When recently exposed, some specimens are very beautiful.

Carbonate of lead, is found in primitive and secondary countries. It accompanies galena, and the other ores of lead; also several of the ores of iron, zinc, and copper.

Jameson remarks, that next to galena, this is the most common ore of lead, but that it never occurs so abundantly, as to make it worth working by itself.

*Localities.* Bohemia, Saxony, Siberia, Chili, Switzerland, and in many of the lead mines of England, and Scotland.

U. S. Mine at Burton, Missouri, incrusting galena. Wythe county, Vir. Perkiomen lead mine, Penn. in double six-sided pyramids with truncated summits; in six-sided prisms,

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What are the crystalline forms of carbonate of lead?—What is the composition of carbonate of lead?—What are the chemical characters of carbonate of lead?



and in oblique four-sided prisms.—*Wetherill*. Also near Lancaster, Penn.

*Species 5. SULPHATE OF LEAD.*

*External characters.* Colours, white, greenish white, grey, red, brown, and green: occurs massive, and in small shining crystals: in the form of rhombic prisms with dihedral summits, the prisms often being so short as to give them an octohedral form; translucent: transparent in thin laminae, lustre splendid, and resinous: streak white: easily scraped by the knife; brittle: sp. gr. 6.29.

*Chemical characters.* Fusible, and easily reduced to the metallic state. Insoluble in nitric acid.

*Composition.* Oxide of lead 72.47: sulphuric acid 26.9; the residue being water, iron, manganese, and silic.—*Stromeyer*.

*Distinctive characters.* Carbonate of lead, which it resembles, effervesces, with acids, and molybdate of lead, which it also resembles, is not easily reduced to its metallic state, by the blowpipe.

It is found with sulphuret of lead, from the decomposition of which it may have been produced.

*Localities.* Zellerfield, in the Hartz, with the ores of copper, iron, and lead. Andalusia, in Spain. Cornwall, Anglesea, and Scotland.

U. S. Perkiomen lead mine, Penn. in octohedrons.—*Wetherill*. Huntington, Conn. Southampton, Mass. in plates or tables, on sulphuret of lead.—*Meade*.

*Species 6. MURIO-CARBONATE OF LEAD.*

*External characters.* Colour, white, with tints of yellow, green, and grey; streak white; occurs in four-sided prisms, often so short as to become cubes; also in rectangular prisms, terminated by four-sided pyramids; both kinds variously modified by truncation; lustre adamantine; structure lamellar; cleavage parallel to all the planes of a four-sided prism; cross fracture conchoidal; transparent, or translucent; rather sectile; brittle: sp. gr. 6.

*Chemical characters.* Fusible, into an orange coloured globe, and on continuing the heat, the acid evaporates, and a minute globule of lead remains.

*Composition.* Oxide of lead 85.5; muriatic acid 8.5; carbonic acid 6.5.—*Klaproth*.

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What are the colours of sulphate of lead?—What is the composition of sulphate of lead?—What is the composition of murio-carbonate of lead?

*Distinctive characters.* Its peculiar behaviour under the blowpipe, will distinguish it from carbonate of lead.

*Localities.* Hausbaden, in Germany, and Matlock, in Derbyshire.

U. S. Southampton lead mine, Mass. in groups of light green, nearly transparent, cubic crystals, with four-sided summits.—*Meade*.

*Species 7. PHOSPHATE OF LEAD.*

*External characters.* Colours, green, brown, grass green, olive, pistachio, and blackish green; sulphur yellow, greenish yellow, wax yellow; aurora red, hyacinth red; hair brown, clove brown; pearl grey, and ash grey; occurs amorphous, in crusts, in concretions, and in crystals; form, the six-sided prism, often truncated on the lateral or terminal edges; also the dodecahedron, or double six-sided pyramid; fracture small grained, or uneven, passing into splintery; lustre glistening, resinous, or adamantine; crystals sometimes acicular, and often grouped; translucent; yields easily to the knife; brittle: sp. gr. 6 to 7.

*Chemical characters.* Before the blowpipe on charcoal, it usually decrepitates, then melts, and on cooling forms a polyhedral globule, the faces of which present concentric polygons; if this globule be pulverized, and mixed with borax, it melts into a milk-white enamel, which, on continuing, the bead becomes transparent, the lower part being studded with globules of metallic lead.—*Aiken*.

*Composition.* Oxide of lead, 77.10; phosphoric acid, 19.0; muriatic, 1.54; oxide of iron, 0.10.—*Klaproth*.

*Distinctive characters.* It differs from carbonate of lead, and carbonate of copper, in not effervescing with acids. Its peculiar behaviour under the blowpipe, will distinguish it from most, if not all other substances.

It is found in primitive and secondary rocks.

*Localities.* Saxony, Bohemia, Siberia, Cornwall, in several lead mines. Lead Hill, in Scotland, Ireland.

U. S. Perkiomen lead mine, Penn. Southampton, Mass.

*Variety 1. ARSENIATED PHOSPHATE OF LEAD.*

*External characters.* Colours, yellow, and greenish yellow, of various shades; occurs crystallized, in the form of the species; also reniform and mamillated; fracture conchoidal; lustre resinous.

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What are the colours of phosphate of lead?—What are the chemical characters of phosphate of lead?

*Chemical characters.* Exhales the arsenical vapour, and yields a globule of lead.

*Composition.* Oxide of lead 76; phosphoric acid 13; arsenic acid 7; muriatic acid 1.75; water 5.—*Klaproth.*

*Localities.* Saxony, and Rosiers in France.

*Variety 2. BLUE LEAD.*

*External characters.* Colour, between lead grey, and indigo blue; occurs massive, and in six-sided prisms, often somewhat bulging, or with convex faces; fracture conchoidal, or fine grained; uneven; lustre glimmering metallic; fragments indeterminate; soft, easily frangible; opaque: sp. gr. 5.46.

*Chemical characters.* Fusible, with the emission of sulphurous vapours, a part of the globule being reduced, while the other part, on cooling, crystallizes in dodecahedrons.

Prof. Silliman supposes this to be a mixture of the sulphuret, and the phosphate of lead, in which opinion he is followed by Prof. Mohs.

*Localities.* Huelgoët, in France, and in Saxony.

*Species 7. ARSENIATE OF LEAD.*

*External characters.* Colours, grass green, wine yellow, hair brown, and yellowish white; occurs in small slender six-sided crystals, either perfect or with truncated edges, and in minute crystals, gathered into bundles, and so arranged as to assume the general appearance of six-sided prisms; translucent, rarely transparent; when transparent scratches glass; lustre resinous; brittle; also occurs in mammillary concretions, and in filaments, with a silken lustre: sp. gr. 5 to 6.4.

*Chemical characters.* Gives out arsenical vapours, and is reduced to metallic lead. It does not effervesce with acids.

*Composition.* Oxide of lead 69.76; arsenic acid 26.4; muriatic acid 1.58.—*Gregor.*

*Localities.* Cornwall, and Devonshire, in several of the lead mines. St. Prix, in the department of Saone, in France.

*Variety 1. RENIFORM ARSENIATE OF LEAD.*

*External characters.* Colours, brownish red, passing into a straw yellow; occurs in reniform masses; fracture conchoidal; lustre glistening, resinous; opaque; soft, brittle: sp. gr. 3.9.

*Chemical characters.* Fusible, with arsenical vapour, into

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What are the varieties of phosphate of lead?—What are the colours of arseniate of lead?

a black globule, out of which ooze little globules of metallic lead.

*Composition.* Lead 25 ; oxide of iron 14 ; silver 1.15 ; arsenic acid 25 ; silice 7 ; alumina 2 ; water 10.—*Bindheim.*

*Distinctive characters.* Arseniate of lead differs from the carbonate, the molybdate, and the phosphate of lead, by the emission of the garlic odour, when heated ; also the carbonate effervesces, the molybdate is with difficulty reduced, and the phosphate crystallizes in polyhedrons on cooling.

*Locality.* Nertschinsk, in Siberia.

*Species 8. MOLYBDATE OF LEAD.*

*External characters.* Colours, wax, or honey yellow, passing into lemon, or orange yellow, and brownish yellow ; occurs in crystals, and rarely massive ; form, the octohedron, variously modified ; sometimes it is truncated on all its angles, or on the solid angles of the summits only : sometimes it is found in four-sided tables, or nearly in the form of a cube, or parallelepiped, or eight-sided table, either truncated or bevelled ; sometimes these tables so intersect each other, as to give the mass a cellular structure ; fracture imperfectly conchoidal ; soft ; brittle ; yields to the knife ; lustre waxy : sp. gr. 5.9.

Fig. 158.



Fig. 158. The octohedron, truncated on all its solid angles.

Fig. 159.

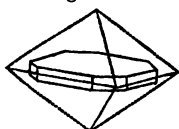


Fig. 159. An eight-sided table, produced by the deep truncation of all the angles of an octohedron, forming the table ; and the truncation of the common base, producing the eight sides.

Fig. 160.



Fig. 160. Another secondary form, in which the solid angles are truncated, with the truncation of the edges of the common base, in form of a scalene triangle.

*Chemical characters.* Fusible into a dark grey mass, which

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What are the distinctive characters of arseniate of lead ?—What are the colours of molybdate of lead ?—What are the crystalline forms of molybdate of lead ?

by the utmost effort of the blowpipe, yields globules of lead. Soluble, without effervescence, in hot nitric acid.

*Composition.* Oxide of lead 64.42; molybdic acid 34.26.

—*Klaproth.*

*Distinctive characters.* It differs from the carbonate and sulphate of lead, in the difficulty of its reduction. The arsenate of lead, emits the garlic odour; the phosphate is not reduced without a flux, and the muriate of lead emits the smell of muriatic acid. Its sp. gr. will distinguish it from the earthy minerals.

*Localities.* Eleyberg, in Carinthia. Zimapan, in Mexico. Annaberg in Austria, and in the Tyrol.

U. S. Perkiomen lead mine, Penn. where it occurs in quadrangular tables, variously modified.—*Conrad.* Southampton lead mine, Mass. in small tabular crystals, of a dark wax yellow.—*Meade.*

#### *Species 9. CHROMATE OF LEAD.*

*External characters.* Colours, orange, or aurora red, or hyacinth red, always rich and beautiful; occurs crystallized, and rarely massive; form, the rectangular four-sided prism, variously modified; also the compressed eight-sided prism, with two, three, or four-sided terminations; crystals often broad and flat; sometimes striated, and generally incomplete, their geometrical characters being difficult to determine; lustre resinous; translucent; yields to the knife: brittle; sp. gr. 6.

*Chemical characters.* Fusible, with crackling, into a greyish slag; tinges borax green.

*Composition.* Oxide of lead 63.96; chromic acid 36.40.—*Klaproth.*

*Distinctive characters.* It differs from the sulphuret of arsenic, from red antimonial silver, and from cinnabar, in this respect, that all these are more or less volatile under the blowpipe, while the present species is fixed.

*Localities.* Beresof, in Siberia, in a gold mine, Cocaes, in Brazil, and Zimapan, in Mexico.

The native chromate of lead, is a rare, and scarce mineral. The artificial chromate is of a beautiful bright yellow, and is employed with oil, in the finer kinds of painting.

The chromic acid, used in the manufacture of this article,

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How is molybdate of lead distinguished from other minerals?—What is the colour of chromate of lead?—What are the distinctive characters of chromate of lead?—What is the use of artificial chromate of lead?

tracted, by a chemical process, from the chromate of

is paint is manufactured at Philadelphia, the chromic being obtained from the chromate of iron, which is found at Baltimore.

#### GENUS 7. BISMUTH.

lour, when pure, reddish white ; lustre brilliant ; texture ad ; softer than copper ; breaks when struck smartly with hammer ; melts at 476, Fah. ; and if the heat be increased, it volatilizes in the form of yellow oxide : may be distilled in a vessel : sp. gr. 9.82.

Uses. It enters into the composition of printing type. Its ores are employed as paints, and in medicine. The ores of bismuth are few, and rarely found.

##### *Species 1. NATIVE BISMUTH.*

*General characters.* Colour, silver white, with a tinge of reddish ; occurs amorphous, plumose, and reticulated ; crystallized in the form of octohedrons and cubes ; structure lamellar, with joints parallel to the planes of an octohedron ; soft ; lustre brilliant ; subject to tarnish : sp. gr. 9.

*Chemical characters.* Easily fusible, and by continuing the heat evaporates in the form of a yellow oxide. Soluble in nitric acid, but is precipitated on dilution with water.

*Distinctive characters.* Native bismuth differs from the sulphuret of bismuth, in not giving out the sulphureous odour when heated ; the sulphuret is also of a pale lead grey colour, and of reddish white ; its want of malleability, and easy fusion will distinguish it from native silver, and native copper, and its colour will distinguish it from native antimony.

It is found in primitive rocks, and particularly in quartz, mica, and mica slate, where it is generally associated with arsenic, and silver.

*Localities.* Saxony, Bohemia, Suabia, Norway, and England each contain localities of this metal.

S. Huntington, Conn. in broad plates, disseminated in granite of quartz.—*Silliman*. Also Trumbull, Conn. in tabular masses, with the sulphurets of iron and lead.—*Phillips*.

##### *Species 2. SULPHURET OF BISMUTH.*

*General characters.* Colour, between lead grey, and

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What is the colour of bismuth ?—What are the uses of bismuth ?—What are the distinctive characters of native bismuth ?

tin white ; occurs amorphous, lamelliform, and acicular ; structure foliated, or fibrous ; cleavage of the foliated, parallel to the sides and shorter diagonal of a rhombic prism ; sometimes occurs in fibrous radiating masses ; lustre shining, metallic ; soft ; brittle : streak unchanged : sp. gr. 6.

*Chemical characters.* Fusible by the flame of a candle ; under the blowpipe, gives the flame and odour of sulphur, and is chiefly volatilized, the residue being with difficulty reduced to its metallic state.

*Composition.* Bismuth 60 ; sulphur 40.—*Sage.*

*Distinctive characters.* It differs from native bismuth, in colour, and in giving the fumes of sulphur, under the blowpipe. Sulphuret of lead is easily reduced to a metallic globule ; sulphuret of antimony disappears entirely before the blowpipe.

*Localities.* These are much the same with those of native bismuth, with which it is commonly found.

### *Species 3.* OXIDE OF BISMUTH.

*External characters.* Colour, greenish, or yellowish grey ; occurs massive and pulverulent ; fracture earthy ; structure imperfectly lamellar ; opaque ; soft ; dull ; and brittle : sp. gr. about 4.37.

*Chemical characters.* Easily reduced, on charcoal, to the metallic state. Soluble in nitric acid.

*Composition.* Oxide of bismuth 86.3 ; oxide of iron 5.2 ; carbonic acid 4.1 ; water 3.4.—*Lampidius.*

### *Genus 8* NICKEL.

Pure nickel is of a brilliant white colour, resembling silver. It is malleable, both hot and cold. It is not so hard as wrought iron, and like it, is magnetic. It fuses at 160° of Wedgewood. In nitric acid, it gives a greenish solution ; tarnishes by heat, and runs through nearly the same changes that heated steel does : sp. gr. 9.

Nickel is not an abundant metal. Its ores are few in number, and rarely found.

### *Species 1.* NATIVE NICKEL.

*External characters.* Colour, when fresh broken, pale yellow, with a tinge of grey ; occurs in slightly flexible needles or filaments, or in tables placed on each other ; not magnetic.

*Chemical characters.* Partially melts, and becomes magnetic and malleable.

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What are the chemical characters of sulphuret of bismuth ?—What is the colour of pure nickel ?—Is nickel a malleable, or a brittle metal ?—Is this an abundant metal ?—Is nickel magnetic, or not ?

**Composition.** Nickel, with a small portion of arsenic, and cobalt, which seems to destroy its magnetism.

**Localities.** Hartz, Saxony, Bohemia, near Salzburg, and Cornwall.

It is also found in nearly every meteoric stone which has been analyzed.

*Species 2. ARSENICAL NICKEL.*

**External characters.** Colours, copper red, or yellowish red; acquires a dark tarnish by exposure; occurs reticulated, botryoidal, and massive; fracture imperfectly conchoidal; lustre, shining metallic; yields with difficulty to the knife; sometimes gives sparks with steel; said to occur in four, or six-sided prisms: sp. gr. 6.60 to 7.70.

**Chemical characters.** Gives out arsenical vapours, and melts with difficulty into a scoria, interspersed with metallic globules. Forms a green solution in warm nitric acid.

**Composition.** Nickel 44.2; arsenic 54.7; iron, lead, and sulphur, in small portions.—*Stromeyer*.

**Distinctive characters.** It has a strong resemblance to native copper, but copper is malleable, and does not emit arsenical vapours. From pyritous copper, it may be known by its garlic odour, and its difficult reduction.

It is found in primitive rocks, with the ores of cobalt, copper, and silver.

**Localities.** Saxony, Bohemia, France, Spain, and Cornwall.

U. S. Chatham, Conn. in a hornblende rock, associated with cobalt.—*Torrey*. Frederic county, Md.

*Species 3. ARSENITE OF NICKEL.*

**External characters.** Colours, apple, or grass green, and greenish white; occurs in the state of a powder adhering to, and coating other minerals, and particularly arsenical nickel; also, more or less compact, and of a fine apple green colour; opaque, or feebly translucent.

**Chemical characters.** Fusible, and reducible with borax, to the metallic state, exhaling a strong odour of arsenic. Dissolves in acids without effervescence.

**Composition.** Oxide of nickel 37.4; arsenious acid 37; water 24.3; oxide of iron 1.1; sulphuric acid 0.2.—*Stromeyer*.

**Distinctive characters.** The carbonate of copper, which it

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Where is nickel found?—What are the colours of arsenical nickel?  
—What is the composition of arsenical nickel?



sometimes resembles, effervesces with acids, and turns black when heated. The oxide of bismuth is easily reduced, and soon evaporated, by the blowpipe.

*Species 4. PIMELITE.*

*External characters.* Colours, apple green, or greenish yellow; occurs in crusts, or small indurated masses; fracture, and texture, earthy; lustre glimmering, or dull; soft, unctuous to the touch.

*Chemical characters.* Infusible, but turns dark grey, and loses a part of its weight.

*Composition.* Oxide of nickel 15.62; silice 35; alumine 5.10; lime 0.40; magnesia 1.25; water 37.91.—*Klaproth.*

*Localities.* Silesia, in several places, where it is associated with chrysoprase, in veins traversing serpentine.

U. S. New Fane, N. H. colour apple green; envelopes chrysoprase. Discovered by Mr. Field.

*Genus 9. COBALT.*

Colour, when pure, greyish white, with a tinge of copper red; lustre, approaching brilliant; melting point, 130° Wedgewood; brittle, and reducible to powder in a mortar; not liable to oxidate on exposure to the air, or if kept under water: sp. gr. 8.7.

Cobalt has not been found in the native state.

*Uses.* Cobalt, in its metallic state, has not been applied to any use; but in the state of an oxide, it is an article of considerable consequence in the arts. *Zaffree* is an impure oxide of cobalt, which, when fused with a certain quantity of glass, forms *smalt*. Smalt is of a deep and rich blue colour, and is the substance which gives the blue colour to china-ware, to enamel, glass, porcelain, &c. Paper, and linen, also, receive their bluish tinge from malt.

The name, *cobalt*, according to Beckmann, comes from *cobaltus*, a title which the German miners gave to an imaginary spirit, which they formerly believed haunted certain mines. This name was given to the ores of cobalt, because, like an evil spirit, they thwarted the hopes of the miners, by raising great expectations when nothing in fact was to be realized, the uses of cobalt being then entirely unknown. It was once customary, therefore, says the same author, to introduce into the church service, a prayer, "that God would protect miners, and their works, from *kobalts*, and spirits."

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What is the colour of cobalt?—Is cobalt found in its native state?—What are the uses of cobalt?

Its uses as a colouring matter, were discovered in about 1640.

*Species 1. ARSENICAL COBALT.*

*External characters.* Colour, tin, or silver white, tarnished externally greyish, or reddish; occurs amorphous, arborescent, reticulated, stalactical, and crystallized in the forms of cubes, and octohedrons with their varieties; crystals often exhibit cracks, and convex surfaces; lustre, glistening and metallic; yields with difficulty to the knife; brittle: sp. gr. 7.3.

*Chemical characters.* Before the blowpipe, it gives out a copious arsenical vapour, on the first impression of the heat; it melts only partially, and that with great difficulty, and is not attractable by the magnet; on the addition of borax, it immediately melts into a grey metallic globule, colouring the borax of a deep blue.—*Aiken*. In the flame of a candle, it emits arsenical vapours.

*Distinctive characters.* The present species, differs from grey cobalt, in being of a more compact, or granular texture, instead of being lamellar; and in emitting the odour of arsenic, when exposed to the flame of a candle. From arsenical iron, it differs, in giving a blue colour to borax, and from antimonial silver by the same test, and also by its garlic odour, which the silver does not emit.

*Composition.* Cobalt 44; arsenic 55; sulphur 0.50.—*Klaproth*.

*Variety 1. GREY ARSENICAL COBALT.*

*External characters.* Colour, tin white, with a tinge of copper red; occurs dendritic, botryoidal, and crystallized in cubes and octohedrons, variously truncated, and perfectly similar to those of the sulphuret or iron; structure lamellar; cleavage, parallel to the planes of the cube; yields with difficulty to the knife; not brittle; lustre metallic, shining: sp. gr. 6.33 to 6.45.

*Chemical characters.* Turns black, and as it grows red hot, emits arsenical fumes, and is finally reduced to a metallic globule, which is magnetic.—*Phillips*.

*Composition.* Cobalt 33.1; arsenic 43.5; sulphur 20.1; iron 3.2.—*Stromeyer*.

*Distinctive characters.* The marks of distinction, between this variety and the species, has already been pointed out.

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What are the chemical characters of arsenical cobalt?—What are the distinctive characters of arsenical cobalt?

All the ores of cobalt are easily distinguished from other minerals, by the deep blue they give to borax.

The present species and its variety, are the ores chiefly wrought for the purpose of obtaining cobalt, for commercial purposes.

Arsenical cobalt occurs in veins, traversing primitive rocks, associated with nickel, bismuth, silver, arsenic, and copper.

*Localities.* Cornwall, and near Dartmoor, in England. Tunaberg, in Sweden. Queerback, in Silesia. Norway. Sweden, Friberg, Marienberg, and Annaberg, in Saxony.

U. S. Chatham, Conn. in a hornblende, and mica-slate rock. This mine was wrought 50 years since, and abandoned. Another attempt has also been made within a few years, but the ore was found too poor to make it profitable, and it is again abandoned.

Nearly all the zaffre and smalt, used in commerce, come from Saxony, where the cobalt mines have been long wrought, with great profit.

*Species 4. ARSENIATE OF COBALT.*

*External characters.* Colours, crimson red, peach blossom red, cochineal red, and sometimes pearl grey, or greenish grey; occurs in botryoidal, and reniform masses, also investing, earthy, slaggy, and in acicular, radiating, or diverging crystals; crystals translucent; massive, opaque and dull; soft; yields to the knife, and sometimes to the nail; thin laminae, flexible: sp. gr. 2.9.

*Chemical characters.* Emits copious arsenical fumes, and tinges borax smalt blue.

*Composition.* Oxide of cobalt 39; arsenic acid 37; water 22.—*Bucholz.*

*Distinctive characters.* The blue colour it gives to borax will distinguish it from red oxide of copper, the red oxide of iron, and the sulphuret of mercury.

It occurs in veins, traversing rocks of various ages, and in beds. It may be considered a common ore of cobalt, and sometimes occurs in sufficient quantities for the manufacture of smalt.

*Localities.* Schneeberg and Annaberg in Saxony, Thuringia, Bieber, in Hessa.

U. S. Chatham, Conn. of a peach blossom red, in crusts, disseminated in felspar.—*Torrey.*

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What is said of grey arsenical cobalt?—What are the colours of arseniate of cobalt?—What are the distinctive characters of arseniate of cobalt?

*Genus 10. IRON.*

Of all metals, this is the most universally diffused, and of greatest use to man.

Its ores are very numerous, and many of them very beautiful and highly interesting. The colour, and many of the properties of pure iron, are too generally known to require any description. In its soft state, it is one of the most ductile of the metals, and in the form of steel it is the hardest of all tallic bodies.

In general the ores of iron are easily detected by their magnetic property. Many of them, as the oxides and sulphurets, which are not magnetic, in their original state, become so on being submitted to the blowpipe on charcoal, with the addition of a little tallow.

The specific gravity of pure iron is 7.7.

*Species 1. NATIVE IRON.*

*External characters.* Colour, pale steel grey, approaching that of platina; occurs massive, reticulated and cellular; fractures hackly; malleable; magnetic; not easily oxidated; has easily occurred in octohedral crystals: sp. gr. 7.7.

*Chemical characters.* Dissolves with effervescence in all strong acids. Its solutions strike a black colour, with the addition of nut-galls.

*Composition.* (From Saxony.) Iron 92.50; lead 6; copper 1.5.—*Klaproth.*

*Localities.* Near Grenoble, in France, mingled with quartz and clay. Near Steinback, in Saxony, in a gangue of garnets.

*Variety 1. METEORIC NATIVE IRON.*

*External characters.* Colour, pale steel grey, usually covered with a coat of what appears to be brown oxide of iron; occurs massive, globular, and rarely in octohedral crystals; is metallic; texture compact, or porous; malleable: sp. gr. 6.48 to 7.57.

*Composition.* (Siberian.) Metallic iron 98.5; nickel 1.5. Nearly every specimen of native meteoric iron which has been examined, has been found to contain nickel in small proportions, as from 1.5 to 10 per cent.

Masses of meteoric iron have been found in various parts of the world.

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What metal is most universally diffused and of the greatest use to man?—What are the chemical and distinctive characters of iron?—What are the characters of meteoric native iron?



Professor Pallas, in his travels, states that he found on the top of a mountain in Siberia, a mass of native iron weighing 1680 pounds. It was malleable and flexible. The inhabitants reported to him, that it fell from the sky.

A mass, now in the imperial cabinet of Vienna, came from Agram, in Croatia. It was seen by the inhabitants to fall from the air, and is said to have appeared like a globe of fire. This event happened in 1751.

In the province of Tucuman, in South America, in the midst of a large plain, Don Rubin de Celis describes a mass of native iron, weighing about 30,000 pounds. It had an irregular indented surface, and internally presented many cavities. It contains 10 per cent. of nickel.

A mass found in Prussia is said to have weighed 1,600 pounds.

A mass found at Bithborg, in France, is mentioned by Col. Gibbs. It weighed, by estimation, about 2,500 pounds. In some parts, it is so hard as to give fire with steel.

A mass, now in the cabinet, at New Haven, was found near Red river, in Louisiana. Its surface is covered by a dark brown crust, and is deeply indented. It is very compact and malleable. This mass weighs upwards of 3,000 pounds. In its interior, Col. Gibbs discovered octohedral crystals of iron, the largest of which is half an inch long.

Capt. Ross mentions a mass of native iron which exists in West Greenland. The Esquimaux have made knives of it. It contains 3 per cent of nickel.

Other masses of the same metal have been discovered in various parts of the globe. That of Croatia, however, seems to be the only one concerning which there is any direct proof of its having fallen from the atmosphere. But the similarity of composition, and the circumstances under which most, if not all of these masses have been found, as their insulation, peculiar composition, and their situation on the surface of the earth, seem to indicate that they owe their origin to a common cause, and that they must have fallen from the atmosphere at various and uncertain periods.

#### *Species 2. ARSENICAL IRON.*

*External characters.* Colour, tin white, with a shade of yellow; occurs massive, disseminated, and crystallized; form, the right rhombic prism, either simple, or terminated by dihe-

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What is said of masses of meteoric native iron?—Why is it supposed, that these masses of iron fell from the atmosphere?—What is the colour of arsenical iron?

dral summits ; also modified by truncation, on the edges of the summits—on each of the obtuse angles, or otherwise ; lustre shining, metallic ; fracture granular ; hard ; brittle ; gives fire with steel, the sparks being attended with a little train of white smoke ; when struck, gives the odour of garlic : sp. gr. 6.5.

*Chemical characters.* Fusible, with volumes of white arsenical smoke, the residue being magnetic iron.

*Composition.* Arsenic 54.55 ; iron 45.46.—*Berzelius.*

*Distinctive characters.* It resembles arsenical, and grey cobalt, but these both tinge borax smalt blue. It also may resemble sulphuret of iron, and antimonial silver, but neither of these emit the garlic fumes.

It is found chiefly in primitive rocks, as gneiss, mica-slate, and granite ; where it occurs in veins, or is disseminated.

*Localities.* Its foreign localities are numerous.

U. S. Warwick, Orange county, N. Y. Near Boston, Mass. Chatham, Conn. Paris, Maine.

*Species 3. SULPHURET OF IRON. COMMON PYRITES.*

*External characters.* Colour, bronze yellow, passing into brass yellow, and steel grey ; occurs crystallized, capillary, cellular, massive, and disseminated ; form the cube, octohedron, dodecahedron with pentagonal faces, and the icosahedron, with trapezoidal faces, with their modifications and varieties ; cleavage parallel to the sides of an hexahedron and octohedron ; fracture conchoidal ; lustre brilliant, metallic ; crystals embedded, and implanted ; hard, brittle : sp. gr. 4.8.

Fig. 161.

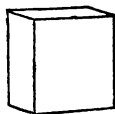


Fig. 162.

Fig. 161. A cube, the primitive form, and one of the most common figures under which it occurs. This is often truncated on all its solid angles.

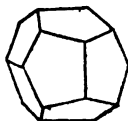


Fig. 162. The dodecahedron with pentagonal faces.

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What are the distinctive characters of arsenical iron ?—What are the colours of sulphuret of iron ?—What are the crystalline forms of sulphuret of iron ?

Fig. 163.



Fig. 163. The octohedron, truncated on all its solid angles.

Fig. 164.

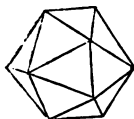


Fig. 164. A solid, bounded by twenty triangular faces.

Haüy has enumerated a great variety of other modifications, some by truncation, others by bevelment.

Sulphuret of iron is often a very beautiful mineral, the crystals being as perfect in shape as could be formed by the most skilful lapidary, and the truncations perfectly symmetrical, together with a surface that resembles burnished gold. They are of all sizes, from that of a mustard seed, to two inches, or even more, in diameter.

*Chemical characters.* Fusible, with a strong odour of sulphur, into a globule, which is magnetic.

*Composition.* Iron 47.85; sulphur 52.15.—*Hatchett.*

*Distinctive characters.* It has often been taken for gold, but gold is malleable; iron pyrites is brittle. It differs from sulphuret of copper in being so hard as not to yield to the knife; pyritous copper yields to the knife, and does not yield a magnetic globule. Arsenical iron emits arsenical fumes, while iron pyrites emits those of sulphur.

#### Variety 1. RADIATED SULPHURET OF IRON.

*External characters.* Colour, bronze yellow, passing into steel grey, often variegated; occurs in masses, of a globular, botryoidal, or reniform shape, composed of fibrous crystals, radiating from the centre, and terminating on the surface of the mass; fracture fibrous; lustre brilliant.

These masses commonly fall into a state of decomposition, if exposed to the air, as in cabinets; in which case they crack in various directions, and become covered with a white efflorescence, which will be found on touching it with the tongue to be sulphate of iron, or coperas.

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How is sulphuret of iron distinguished from other minerals?—What are the varieties of sulphuret of iron?

**Variety 2. HEPATIC SULPHURET OF IRON.\***

*External characters.* Colour, liver brown; internally pale brass yellow, inclining to steel grey; occurs in hexahedral, and octohedral crystals, also stalactical, botryoidal, and amorphous; lustre glimmering.

This variety presents most of the forms of iron pyrites.

Its colour seems to arise from a peculiar kind of decomposition, the nature of which is not well understood, and by which its colour is changed, and its lustre disappears, without any change of form.

It is found in veins in primitive rocks.

U. S. Near Sparta, N. J. Staten Island, and at Anthony's nose, N. Y.

*Arsenical sulphuret of iron.*—Colour, steel grey, paler than common pyrites; it yields arsenical, as well as sulphureous vapours.

*Auriferous sulphuret of iron.*—Colour, deep yellow; occurs in grains and cubic crystals; contains a small quantity of gold, which seems to be in a state of simple mixture with the pyrites.

*Seleniferous sulphuret of iron.*—Colour, pale yellow; occurs in granular masses.

*Pseudomorphous sulphuret of iron.*—It occurs in the crevices of wood, and minerals, and also in the cavities of organic remains, and takes its form from that of the cavity, in which it is found.

*Uses.* Sulphuret of iron is a very abundant, and universally distributed ore. It however is seldom, if ever, employed for the making of iron, but is chiefly used for the extraction of the sulphate of iron or *copperas*, by decomposition.

For this purpose, the ore, being raised from the earth, is exposed to the air, and moistened. By a natural process, the sulphur absorbs oxygen from the atmosphere, and is converted into sulphuric acid. The acid then unites to the iron, and forms a sulphate, which appears in the form of a greenish white crust on the decomposing pyrites. The copperas is then obtained by washing, or lixiviation, and subsequent crystallization.

In the United States, manufactories of the sulphate of iron have been established in Tennessee. In Maryland, about twenty miles from Baltimore. In Ohio, near Zanesville, and

\* From *hepar*, Lat. *hepar*; because it is of a liver colour.

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What are the uses of sulphuret of iron?—How is sulphate of iron manufactured?



on the Muskingum river, and at Steubenville. In Vermont, at Strafford, and Shrewsbury. At Strafford, about one thousand persons are employed in the several departments of this manufactory, and during the last year, (1825,) seven hundred tons of copperas have been produced.

*Species 4. MAGNETIC SULPHURET OF IRON.*

*External characters.* Colour, between bronze yellow and copper red; occurs massive; rarely in six-sided prisms; structure lamellar; turns brown by exposure; obedient to the magnet.

*Chemical characters.* Fusible with the sulphureous odour, into a magnetic globule.

*Composition.* Iron 63.5; sulphur 36.5.—*Hatchett.*

This variety contains less iron and more sulphur than the other species. Its magnetic property, Haüy supposes, may depend on its containing a portion of iron in its pure state, and not united to the sulphur. In the opinion of Mr. Hatchett, iron combined with less than 37 per cent. of sulphur, may not only affect the needle, but become a permanent magnet, which is the case with the present species.

*Localities.* Hartz, Galloway, in Scotland, and various other places.

U. S. Brookfield and Huntington, Conn. Near Boston, Mass. Brunswick, Maine.

*Species 5. MAGNETIC OXIDE OF IRON.*

*External characters.* Colour, iron black; occurs crystallized, lamelliform, and massive; form the regular octohedron, dodecahedron with rhombic faces, cube and four-sided prism terminated by four-sided pyramids; all subject to a variety of truncations; structure imperfectly lamellar; fracture uneven; lustre shining or glimmering; faces often striated; occurs also in thin plates and in the state of sand: sp. gr. 4.4.

*Chemical characters.* Becomes brown but is infusible. Insoluble in nitric acid.

*Composition.* Peroxide of iron 71.86; protoxide of iron 28.14.—*Berzelius.*

This species is always attracted by the magnet, and sometimes attracts iron which has not been magnetized; it then is called *native magnet*, or *loadstone*.

In other instances, iron is said to be magnetic when it disturbs the polarity of the magnetic needle, without possessing

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What is the colour of magnetic oxide of iron?—What is loadstone?

the power of imparting the same quality ; but the native magnetic iron, not only attracts its own particles, but those of iron, which before were not magnetic, and has the power of imparting this property, thus forming the artificial magnet.

The loadstone is chiefly found in primitive countries, and sometimes constitutes large masses, or even beds.

According to Patrin, there occurs in Sweden, and Switzerland, whole mountains composed of magnetic iron, immense masses of which are found to be native magnets. Blocks of 40lbs. weight, he says, would carry 200lbs. of iron, and sometimes pieces were found which would lift 25 times their own weight of iron.

The celebrated Bergman also describes a hill of the same kind of iron ore, which he saw at Talberg, in Swedish Lapland. It is a league in circuit, and 400 feet high, and consists, to appearance, solely of black iron ore, cemented into a hard and solid mass, with quartz.—*Pinkerton's Petrology.*

From its external appearance, the native magnet does not differ from common magnetic oxide of iron, but on trial it will be found to attract iron filings, and to possess polarity.

U. S. Goshen, Penn. On the river Wachitta, Arkansas Territory. Topsham, Maine.

#### Variety 1. SANDY MAGNETIC OXIDE OF IRON.

*External characters.* Colour, iron black ; occurs in small dodecahedral, and octohedral crystals, and in minute grains constituting iron sand ; strongly magnetic ; powder black.

*Chemical characters.* Infusible, and unalterable by the blowpipe.

*Composition.* Oxide of iron 85.50 ; oxide of titanium 14 ; oxide of manganese 0.50.—*Klaproth.*

This variety being sifted, is in common use for desk, or writing sand.

*Localities.* U. S. West Haven, Conn. on the beach of the sea shore. It very obviously proceeds from the disintegration of the chlorite slate contiguous to the beach.—*Silliman.* On Block Island, R. I. Gill, Mass. Also in Maryland, Ohio, and Virginia.

Magnetic oxide of iron is found very abundantly in foreign countries, and is known under the name of *mountain ore*. It furnishes the best bar iron, and is that from which the Swe-

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What is said of the quantities of magnetic oxide of iron ?—What is said of sandy magnetic oxide of iron ?—What is the common name for this species ?

dish steel is made. It yields from 50 to 90 per cent. of metallic iron.

*Localities.* U. S. Franconia, Grafton county, N. H. The bed is from 5 to 8 feet thick, and is contained in gneiss. Beautiful octohedral, and dodecahedral crystals are common. It also yields the compact variety. This bed is explored for smelting. Topsham, Lincoln county, Maine. Some of the crystals are two inches in diameter.—*Cleveland.* Suckasunny, N. J. where the bed has been worked to the depth of 100 feet. The ore from the lowest part is not magnetic until it has been exposed to the light and air.—*Gibbs.* Near Lake Champlain, N. Y. Also in the Highlands, and at Crown Point.—*Gibbs.* Williamstown, Middlefield, and Woburn, Mass. Somerset, Ver. In various places in Pennsylvania, &c.

*Species 6.* SPECULAR OXIDE OF IRON.

*External characters.* Colour, steel grey, with the surface highly polished, and often tarnished azure blue, green, or red, sometimes resembling tempered steel, and sometimes passing into blackish blue; streak cherry red, or reddish brown; occurs crystallized in a great variety of forms, among which are the pyramidal octohedron, with its modifications; the pyramidal dodecahedron, with its summits replaced; the hexahedral table, with the edges replaced, &c.; primary, the slightly acute rhomb; structure lamellar; cross fracture conchoidal; lustre brilliant, metallic; faces of the crystals often striated; slightly attracted by the magnet: sp. gr. 5.52.

Fig. 165.



Fig. 165. A figure bounded by 24 faces, of which six are isosceles triangles, twelve scalene triangles, and six pentagons.

The beautiful iridescent specimens, which come from the isle of Elba, are frequently crystallized in the above form.

The present species often occurs in groups of tabular or lenticular crystals, implanted edgewise, or intersecting each other so as to form cells of various shapes. Sometimes the edges only appear distinct, forming groups resembling the lancets of a *scarificator*.

*Chemical characters.* Infusible, but becomes reddish. Insoluble in acids.

What are the colours of specular oxide of iron?—What are its crystalline forms?—What is said of the beauty of this species?

*Composition.* Iron 69 ; oxygen 31.—*Hassenfraz.*

*Distinctive characters.* It differs from the magnetic oxide, in yielding a red powder, that of the magnetic being black. Grey copper and galena, are reduced by the blowpipe, and are not at all magnetic.

Some of the most splendid specimens, seen in cabinets, belong to this species. It occurs chiefly in primitive mountains, associated with magnetic iron, red oxide of iron, and quartz.

*Localities.* Elba affords the finest specimens, where it is very abundant, and is said to have been worked as a mine, for 3000 years. Saxony, Bavaria, Bohemia, and in most other countries.

U. S. Near Baltimore, Md. Near Lake Champlain, N. Y. Brighton, and Montague, Mass. Jamaica, Ver.

*Variety 1.* VOLCANIC SPECULAR OXIDE OF IRON.

It is found in lava, and possibly, also, in the stones used in smelting furnaces, when they become porous and partially disintegrated by the heat. The writer has seen some beautiful crystals of specular iron, contained in a micaceous sandstone, which had been used for the above purpose, and which, to all appearance, had been formed by particles of iron from the furnace.

*Variety 2.* MICACEOUS OXIDE OF IRON.

*External characters.* Colour, iron black, passing into steel grey ; when turned in a particular direction towards the light it has a tinge of red ; streak and powder cherry red ; translucent, in thin laminæ, when it appears blood red ; occurs massive, composed of thin laminæ, easily separable ; splits into broad pieces, of a slaty aspect ; also occurs in distinct tabular crystals ; sometimes a little unctuous to the touch ; brittle : sp. gr. nearly 4.

*Distinctive characters.* From earthy minerals, it is sufficiently distinguished by its weight, colour, and lustre, and from the other ores of iron, by its micaceous structure.

Specular and micaceous iron, are found in primitive rocks, among the other ores of iron. Sometimes they are disseminated in the other ores, and sometimes they form considerable beds alone.

*Localities.* Near Baltimore, Md. Near the Raritan, N. J. Fort Lee, N. Y. Hawley, Brighton, and Charlestown, Mass. New Stratford, Conn. Near Belfast, Maine. Madison coun-

*What is the form of micaceous oxide of iron ?*



ty, and Washington county, Missouri. In the latter county, micaceous iron forms a ridge from 500 to 600 feet high, and half a mile long.—*Schoolcraft*.

*Species 7. BROWN OXIDE OF IRON.*

*External characters.* Colours, brown, blackish brown, or yellowish brown; occurs stalactical, nodular, fibrous, and amorphous; and according to Mohs, in cubical crystals; powder, yellowish brown; seldom magnetic: sp. gr. 3.44.

*Chemical characters.* Infusible, but turns reddish, and acquires the magnetic property.

*Composition.* Oxide of iron 85; water 15.—*Daubisson*.

*Variety 1. FIBROUS BROWN OXIDE OF IRON. BROWN HEMATITE.*

*External characters.* Colour, brown, yellowish, or blackish brown; on the outside, often varnished or glossed, precisely resembling black glazed earthen ware; occurs stalactical, tuberoso, nodular and amorphous; structure fibrous, sometimes parallel, but more often radiating, or diverging from a centre; lustre, silky or resinous; yields to the knife.

This variety often presents very curious imitative forms; as of cylinders of the size of a pipe stem, many inches long, and interwoven into a sort of net-work; also of the branches of trees, or of coral, or bunches of grapes, &c.

This ore is found in primitive and secondary rocks.

*Localities.* It is found in every country of Europe.

U. S. Messersburg, Jenkintown, and Lancaster, Penn. Gallatin county, Illinois. Lawrence county, Arkansas Territory. Burlington county, N. J. Staten Island, N. Y. Stalactical and mammillary, often with a shining surface.—*Pierce and Torrey*. Salisbury, Conn. specimens often covered with a jet black shining gloss, like the black glazed teapots of former times. Some very beautiful specimens come from this locality. Bennington, and Monkton, Ver. That of Bennington yields 33 per cent. of iron.—*Hall*.

*Uses.* It is employed as an iron ore, and yields from 30 to 60 per cent. of the metal.

*Variety 2. COMPACT BROWN OXIDE OF IRON.*

*External characters.* Colour, olive brown, passing into blackish brown; occurs massive, stalactical, cellular and amorphous; streak and powder yellowish brown; lustre none;

How is brown oxide of iron described?—What use is made of brown oxide of iron?—What is said of the imitative forms of brown hematite?

structure compact, sometimes slaty, but never fibrous; fracture conchoidal, or earthy, yields to the knife: sp. gr. 3.5 to 3.7.

*Composition.* Iron 82; water 11.3; oxide of manganese 0.3; silex 2.6.—*Daubisson.*

*Distinctive characters.* It is distinguished from the hæmatite, by its compact structure.

It usually occurs with the fibrous variety, into which it gradually passes.

*Locality.* Blue Ridge, Md. It occurs in stalagmites, or very beautifully dendritic, resembling, in large masses, a grove of trees.—*Hayden.*

*Uses.* It is explored as an iron mine, and is said to yield about 50 per cent. of metal.

*Variety 3.* OCHERY BROWN OXIDE OF IRON.

*External characters.* Colour, pale brown, or yellowish; occurs massive, of an earthy aspect; soils the fingers; friable.

*Composition.* Iron 83; water 12; silex 5.—*Daubisson.*  
It is found among bog iron ore.

*Variety 4.* UMBER.

*External characters.* Colour, olive brown, blackish or yellowish brown; occurs massive; lustre none; fracture conchoidal; texture earthy; soils very much; easily broken; adheres strongly to the tongue; falls to pieces in water: sp. gr. 2.

*Composition.* Oxide of iron 48; oxide of manganese 20; silex 13; alumine 5; water 14.—*Phillips.*

*Locality.* Cyprus. It is used as a paint.

*Species 8.* RED OXIDE OF IRON.

*External characters.* Colour, reddish brown, streak and powder, blood red, or brownish red; sometimes slightly magnetic; yields to the knife; aspect rather earthy than metallic; rarely found crystallized; opaque; texture fibrous, or compact: sp. gr. 3 to 5.

*Variety 1.* FIBROUS RED OXIDE OF IRON. RED HÆMATITE.

*External characters.* Colours, yellowish brown, and brownish red, or steel grey; lustre somewhat metallic; receives a polish; streak and powder, nearly blood red; occurs amorphous, stalactical, botryoidal, and in concretions; structure distinctly fibrous; fibres, particularly of the stalactical, ra-

diate from the centre, or run parallel, resembling the grain of wood ; fracture conchoidal in one direction : sp. gr. 4.75.

*Chemical characters.* Infusible, but turns dark, and becomes magnetic.

*Composition.* Oxide of iron 90 ; silex 2 ; lime 1 ; water 3.—*Daubisson.*

It is found chiefly in primitive, but sometimes in secondary mountains.

*Localities.* It is found in several European countries, as England, Bohemia, Saxony, &c.

U. S. Perkiomen lead mine, Penn. Kent, Conn.

*Uses.* It is said to yield the best of iron, particularly for drawing and rolling. It is also used for polishing buttons, under the name of *blood-stone*, and during our late war was in great demand, and sold at exceedingly exorbitant prices, for this purpose.

#### *Variety 2.* COMPACT RED OXIDE OF IRON.

*External characters.* Colour, brownish red, with a mixture of steel grey ; surface, sometimes steel grey ; streak, and powder, blood red ; fracture conchoidal or uneven ; lustre a little metallic ; occurs massive, slaty, globular, and reniform ; also in pseudomorphous crystals, generally cubic, with truncated angles : sp. gr. 3.5 to 5.

It is found in primitive, and secondary rocks, with red hæmatite, and other iron ores.

*Localities.* U. S. On Elk river, Tenn. very hard, and compact.—*Schoolcraft.* Canton, N. Y.—*Hall.* At the head of Gasconade river, Missouri.

#### *Variety 3.* OCHERY RED OXIDE OF IRON. RED OCHRE.

*External characters.* Colour, dark blood red, passing into yellowish, or brownish red ; occurs massive ; texture compact, earthy ; soils the fingers, but is not unctuous ; friable : sp. gr. about 3.

It is found with the preceding varieties, and occurs in many places in this country.

*Uses.* It is sometimes employed as a pigment, under the name of *Indian red* ; but more commonly, it is believed, under that of Spanish brown.

#### *Species 9.* ARGILLACEOUS OXIDE OF IRON.

*External characters.* Colours, ash grey, bluish brown, and

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What is the composition of red hæmatite ?—What are the uses of red hæmatite ?—What are the varieties of red oxide of iron ?



reddish brown ; occurs amorphous, and in flat tabular masses ; also reniform, globular, and pulverulent ; fracture uneven, and earthy, or flat conchoidal ; yields easily to the knife ; adheres to the tongue : sp. gr. 3.37.

*Chemical characters.* Infusible, but turns black, and becomes magnetic.

*Composition.* Protoxide of iron, with a trace of manganese, 43.26 ; alumine and silex 20.78 ; carbonic acid 29.30 ; carbonaceous matter 2.67 ; lime 1.87 ; moisture 1.—*Phillips*.

It occurs in secondary rocks, and is found in most countries.

*Variety 1.* COLUMNAR ARGILLACEOUS OXIDE OF IRON.

*External characters.* Colour, red, brownish, or blackish red, and yellowish red ; occurs in masses, composed of columnar pieces, fitting each other like grain, tin or starch, and sometimes with interstices filled with bitumen, or calcareous spar ; texture fine grained, earthy ; brittle ; adheres to the tongue ; sometimes magnetic : sp. gr. 3. to 4.4.

*Composition.* Oxide of iron 50 ; water 13 ; silex 30.5 ; alumine 7.—*Brocchi*.

*Localities.* U. S. Navesink hills, N. J. Long Island, N. Y. Martha's Vineyard, Mass.

It is not common, but is sometimes explored as an iron mine.

*Variety 2.* PISIFORM ARGILLACEOUS OXIDE OF IRON.\*

*External characters.*—Colours, brown, yellowish brown, or blackish brown ; occurs in small globular masses, consisting of concentric layers of the size of a pea, or larger ; brittle ; fracture conchoidal ; lustre, resinous at the circumference, but dull and earthy at the centre.

*Composition.* Oxide of iron 48 ; alumine 31 ; silex 15 ; water 6.—*Daubisson*.

It is found in clay, and soft calcareous deposits, with the bog-ore.

*Localities.* It is abundant in France, and in several parts of Switzerland. It is also found in England, Franconia, and Suabia.

U. S. Pompton plain, and other places, N. J. Staten Island, N. Y. Salisbury, Windsor, and Hartford, Conn.

\* From its resemblance to peas.

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What is the composition of argillaceous oxide of iron ?—What are the varieties of argillaceous oxide of iron ?



*Uses.* It is explored in France, and Switzerland, but said not to yield good iron.

*Variety 3.* LENTICULAR ARGILLACEOUS OXIDE OF IRON.

*External characters.* Colour, brownish red, yellowish brown, or greyish black; occurs in lenticular or oblong flattened masses, of various sizes, from that of an apple seed to that of a butternut; lustre of the fracture, somewhat metallic; easily broken: sp. gr. 3 to 3.8.

*Chemical characters.* Becomes magnetic, but does not easily melt alone; with borax melts into a yellowish green glass.

*Composition.* Oxide of iron 64; water 5; alumine 23 silice 7.5.—*Lampidius.*

*Localities.* Franconia, Bavaria, Saltzburg, Switzerland, France, &c.

U. S. Ontario, N. Y. in an alluvial deposit, which also contains fossil shells.—*Eaton.*

*Uses.* It is sometimes explored as an iron mine, and is said to yield from 30 to 60 per cent.

*Variety 4.* NODULAR ARGILLACEOUS OXIDE OF IRON.

*External characters.* Colour, yellowish brown, or yellow, internally, when fresh fractured; occurs in nodules of various sizes, from that of a nut, to that of a man's head; sometimes hollow internally, and sometimes contains a pulverulent nucleus; fracture, even, earthy, or flat conchoidal, generally earthy towards the centre; texture earthy, or compact, towards the circumference; appears to be composed of concentric layers: sp. gr. about 3; in the hardest parts scarcely yields to the knife.

It is found in clay-slate, and in alluvial deposits.

Sometimes there is a cavity in the centre of these nodules, containing some small loose stones, or sand, which rattles on being shook. The ancients supposed, but on what grounds, we do not know, that the eagles had a habit of transporting those balls to their nests, for the purpose of facilitating the laying of their eggs. Hence they were called *Eagle stones*.

*Localities.* U. S. Near Baltimore, Md. it forms extensive beds. The nodules are composed of concentric layers, and frequently contain minute crystals of sparry iron.—*Gilmer.* Also at Bomb-shell hill, near Bladensburg, in nodules from two to eight inches in diameter. When exposed to a strong heat

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What peculiarity exists with respect to the nodular variety of this species?

they burst with an explosion.—*Hayden*. Near Plymouth, Mass. Nodules, of a reddish grey colour, externally, with a soft, or friable, yellowish nucleus, occur at Northington, Conn. They appear to be formed of fine sand-stone.

*Species 10.* BOG IRON ORE.

*External characters.* Colours, yellowish, brown, brownish yellow, and reddish grey; occurs amorphous, tuberous, and cellular; fracture earthy, or uneven; lustre resinous, or dull; often friable; sometimes resembles scoria, and sometimes ochre; soils the fingers; sp. gr. 2 to 3.

*Variety 1.* FRIABLE BOG ORE.

It occurs in masses, sometimes corroded or sinuous; soils the fingers; dull; appears earthy or ochery.

*Variety 2.* COMPACT BOG ORE.

It occurs amorphous, tuberous, and in crusts; fracture conchoidal; lustre resinous; soft; yields to the knife; soils the fingers.

These varieties, to which some add *Indurated*, occur together, commonly in the same specimen. They are found in low swampy ground, in almost every section of country.

Bog ore is considered of the most recent formation, indeed it is supposed to be deposited every day, from waters containing oxide of iron, and therefore is constantly forming.

*Uses.* It is employed for the extraction of iron, and yields, from 30, to 60 per cent. of metal.

*Species 11.* FRANKLINITE.\*

*External characters.* Colour, iron black, powder deep red, or reddish brown; occurs in granular masses, composed of imperfect crystals, or small grains, which sometimes exhibit the planes of the octohedron, structure lamellar; aspect similar to octohedral iron: sp. gr. 4.87; magnetic.

*Chemical characters.* Soluble without effervescence in hot muriatic acid, exhaling a slight odour of chlorine. Before the blowpipe, the zinc is volatilized, leaving a hard magnetic alloy of iron and manganese, susceptible of a polish.

*Composition.* Oxide of iron 66; oxide of zinc 17; oxide of manganese 16.—*Berthier*.

*Locality.* U. S. New Jersey, accompanied by the red

\* In honour of Dr. Franklin.

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What is said of bog iron ore?—What use is made of the bog ore?—What is the composition of Franklinite?

oxide of zinc, and yellowish green garnet. It is mostly embedded in the red oxide of zinc.

*Species 12. HYDROUS OXIDE OF IRON.*

*External characters.* Colour, iron black, internally blackish brown; occurs massive, and crystallized; structure of the massive, fibrous and radiating; crystals very minute; the terminations, sometimes appearing like velvet; also occurs in slender stalactites, composed of fibres radiating from the centre to the circumference; scratches glass.

*Composition.* Oxide of iron 80.25; water 15; silex 3.75.—*Vauquelin.*

*Localities.* Clifton, near Bristol, in quartose geodes, also near Botallack, Cornwall, Siberia, and France.

*Species 13. CARBONATE OF IRON.*

*External characters.* Colours, wine yellow, yellowish brown, or greyish yellow; becomes brownish black, by exposure; occurs massive; composed of crystalline, foliated plates, often curved; structure foliated or lamellar; lustre shining vitreous; streak white; translucent when recently broken; occurs also in acute rhomboids, sometimes with truncated terminal angles, in six-sided crystals, in octohedrons, and in lenticular crystals; crystals often adhere by thin edges to other minerals, or are found in groups, or druses; yields to the knife; cleavage parallel to the planes of an obtuse rhomboid, which is the primitive form: sp. gr. about 4.

*Chemical characters.* Infusible, blackens and becomes magnetic. Dissolves slowly in nitric acid, with slight effervescence.

*Composition.* Oxide of iron 58; carbonic acid 35; oxide of manganese 4.25; magnesia 0.75; lime 0.5.—*Klaproth.*

*Distinctive characters.* From the earthy minerals which it resembles, it is distinguished by its great weight; from other ores of iron by its crystalline, foliated cleavage, or fracture; and from blende, which it often very nearly resembles, by its yielding magnetic iron, by the blowpipe.

On being exposed to the air, it is gradually decomposed; first the colour of the surface becomes brown, or black; afterwards, also, the streak is changed into red or brown, its hardness and specific gravity are diminished, and even the chemical constitution is altered, the whole being converted into hydrate of iron.—*Mohs.*

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What are the colours of carbonate of iron?—What is the composition of carbonate of iron?—How is carbonate of iron distinguished?

It occurs abundantly in some countries, in veins and beds, chiefly in primitive rocks, but sometimes in secondary ones. It is associated with the other ores of iron, also with those of copper, and lead, and with calcareous spar, brown spar, &c.

*Localities.* Hesse, Hartz, and Westphalia, where it is worked as an ore of iron. France, Germany, and Spain, in abundance. England sparingly.

U. S. Near Baltimore, Md. in lenticular crystals. New Milford, Conn. chiefly in foliated masses, but sometimes in obtuse rhombs.—“This appears to be the only locality in the U. States, where carbonate of iron occurs in quantity.”—*Silliman*.

#### *Species 14. PHOSPHATE OF IRON.*

*External characters.* Colour, indigo blue, sometimes nearly black, and sometimes greenish blue; occurs crystallized, massive and amorphous; form of the primitive, an oblong four-sided prism, which is also the form under which it often appears; crystals subject to truncation. It also occurs in six, eight, or twelve-sided prisms, and in rounded, flattened, or lenticular crystals; structure fibrous, resembling hornblende; crystals grouped, or intersect each other, leaving interstices or cells; lustre shining; the massive is laminated, or consists of shining plates, adhering together; the indurated occurs in friable crusts, or in small masses, with an earthy texture: sp. gr. 2.69.

*Chemical characters.* Fusible into a steel coloured globule, which is magnetic.

*Composition.* Oxide of iron 41.25; phosphoric acid 19.25; water 31.25; alumine 5.—*Laugier*.

*Distinctive characters.* A little attention to colour will distinguish it from hornblende; from the blue carbonate of copper, it differs in being of darker colour; and from this and indicolite, it differs in yielding a magnetic globule.

*Localities.* Isle of France. Allier, in France, Cornwall, and Devonshire in England. Siberia. Bodenmais, in Bavaria. Stavern, in Norway.

U. S. New Jersey. It is transparent when first taken from the earth, but becomes deep indigo blue by exposure, or by a moderate heat.—*Woodbridge*. Also on Crosswick's

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What is the colour of phosphate of iron?—What is the composition of phosphate of iron?—What are the distinctive characters of phosphate of iron?

creek, colour externally blue, but greenish internally, and soft, like talc.

**Variety 1. EARTHY PHOSPHATE OF IRON.**

*External characters.* Colours, on its first exposure, greyish, yellowish, or greenish white, but soon changes to indigo blue of various shades; occurs massive, disseminated, and investing other minerals; soft; often very slightly cohering; dull soils the fingers: sp. gr. about 2.

*Chemical characters.* Becomes brown, and then melts into a magnetic globule.

*Composition.* Oxide of iron 47.50; phosphoric acid 32; water 20.—*Klaproth.*

This variety is found in alluvial soils, as in mud and clay, supposed to be more or less intermingled with animal matter, and from whence it is probable the phosphoric acid has been derived. Indeed, it has been found penetrating the organic remains of several animals.

*Localities.* Isle of Dogs, Isle of Man, and in the Shetland Islands, in England.

U. S. Allentown, and other places, N. J. Near Plymouth, and at Hopkinton, Mass. York, in Maine. At Allentown, it occurs in masses which weigh 30lbs. or more.—*Conrad.*

*Uses.* Phosphate of iron is sometimes ground and employed as a pigment.

**Species 15. CHROMATE OF IRON.**

*External characters.* Colour, blackish brown, or nearly black; occurs massive, disseminated, granular and crystallized in regular octohedrons, or double four-sided pyramids, sometimes flattened; powder and streak brownish; lustre imperfect metallic; opaque; brittle; crystals sometimes so minute as to resemble a tuft of hair, and sometimes of considerable size; fracture conchoidal, or uneven: sp. gr. 4 to 4.50; sometimes magnetic.

*Chemical characters.* Infusible alone, but with borax, yields a rich and lively grass green bead.

*Composition.* Oxide of iron 34.7; chromic acid 43; alumine 20.3; silica 2.—*Vauquelin.*

*Distinctive characters.* The green tinge it gives to borax, will distinguish it from octohedral iron, which it most resembles, and from the dark varieties of blende.

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What use is made of phosphate of iron?—What are the external characters of chromate of iron?—What are the distinctive characters of chromate of iron?

This species is usually found embedded in serpentine, steatite, or talc.

*Localities.* Near Grassin, department of Var, in France, in nodules and veins, in serpentine. Uralian mountains, in Siberia. Shetland Islands. In Bohemia, Silesia, and Piedmont.

U. S. Loudon county, Va. Bare Hills, near Baltimore, Md. in great abundance, in serpentine. From this locality, according to *Hayden*, it extends through Pennsylvania, New Jersey, and New York, to Milford, in Connecticut. From 10 to 14 miles from Philadelphia, on the West Chester and Lancaster roads, it occurs in detached masses, weighing from a few ounces to 20 pounds, and in one instance 500 pounds.—*Cooper*. Hoboken, N. J. in octohedral crystals. On Staten Island, N. Y. Milford, Conn. disseminated in serpentine. Cummingtown, Mass.

*Uses.* Chromate of iron is employed to furnish the *chromic acid*, which, being united with oxide of lead, forms the chromate of lead, or *chrome yellow*, a yellow pigment in great demand.

The chromate of iron is worth from 40 to 60 dollars a ton in market. The chromate of lead sells in large quantities for \$1,00 a pound, and in smaller quantities, or by the single pound, \$1,25 to \$1,50. It is stated that in 1819, about 3,000 pounds of the chromate of lead were manufactured in Philadelphia.—*Cleveland*.

#### *Species 16.* ARSENIATE OF IRON.

*External characters.* Colour, olive green, passing into bottle green and brownish green; also yellowish brown, and yellowish red; streak, and powder, pale brown; occurs in small, and often very perfect cubes, sometimes truncated on the alternate angles, or on the edges and angles; crystals longitudinally striated; lustre adamantine; sometimes occurs stalactical, and studded with crystals; fracture imperfectly conchoidal; transparent, translucent, or opaque; yields to the knife: sp. gr. 3.

Fig. 166.



Fig. 166. A cube, with a triangular face on each alternate, solid angle, formed by truncation.

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What is the use of chromate of iron?—What are the colours of arseniate of iron?





**Localities.** Kongsberg, in Norway. Joachimsthal, in Bohemia, and in Cornwall, England.

*Species 2.* GREEN OXIDE OF URANIUM.

**External characters.** Colour, emerald, or grass green, often very beautiful; also, yellowish green, leek green, and lemon yellow; streak pale; occurs crystallized in quadrangular prisms, in four, six, and eight-sided tables, and rarely, in obtuse octohedrons; all the varieties subject to truncation; crystals variously grouped, sometimes resembling a fan, and sometimes a sheaf; sometimes it appears like a scale of mica, attached to some other mineral; structure foliated; cleavage, easy in certain directions; lustre glistening, and sometimes pearly; transparent, translucent; yields to the knife: sp. gr. 3.10.

Fig. 168.



Fig. 168. An eight and four-sided tabular crystal, one of the common forms.



Fig. 169.



Fig. 169. An octohedron, with truncated summits, and truncated angles.

**Chemical characters.** Decrepitates, but does not melt. Dissolves in nitric acid, yielding, when the solution is saturated, a lemon yellow solution; with borax, yields a yellowish green glass.

**Composition.** Oxide of uranium 72.15; water 15.70; lime 6.87; oxides of tin and manganese 1.55; gangue 2.50.—*Berzelius.*

According to the analysis of Phillips, a specimen from Cornwall, yielded oxide of uranium 60; oxide of copper 9; phosphoric acid 15.3; water 13.8; siliceous 0.5.

If this is the composition of the present species, it is a phosphate of uranium, probably coloured by phosphate of copper.

**Distinctive characters.** It resembles green mica, but the mica is elastic, while the uranium is easily broken, and is inelastic; mica is also more easily cleaved. It may resemble some of the green ores of copper, but copper, when dissolved

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What are the external characters of green oxide of uranium?—What are the distinctive characters of green oxide of uranium?



in nitric acid, yields a blue colour with ammonia, which the uranium does not.

It is found in primitive rocks, and particularly in granite.

*Localities.* Cornwall, where it is found in granite, with the ores of copper, arseniate of iron, wavellite, &c. Bodenmais, in Bavaria, with felspar and beryl. Near Autun, and near Limoges, in France.

U. S. Near Baltimore, Md.—*Gilmor*.

#### *Genus 12. TIN.*

Tin is a white metal of considerable lustre, and not easily oxidated by exposure. It is easily cut with a knife, but is not so soft as lead. When bent, it makes a peculiar crackling noise, probably owing to the separation of some of its particles. It is very malleable, and is readily reduced into thin sheets. It melts at  $442^{\circ}$  Fah. : sp. gr. 7.29.

*Uses.* Tin is employed for various, and very important purposes. Thin sheets of iron, being dipped into melted tin, receive a coat of the metal, and are thus prevented from rusting. This is commonly called *sheet tin*, and is the article of which the common tin ware is made. Tin foil, with mercury, forms the amalgam on the backs of looking-glasses. Tin also forms a part of prince's metal, Britannia metal, pewter speculum metal, &c.

It was formerly supposed that tin was sometimes found in its native state, but Mr. Phillips observes, that this error arose from there having been found pieces of the metal at the sites of old smelting places, and which had been reduced by the heat, long before.

The ores of tin are only two, an oxide and a sulphuret.

#### *Species 1. OXIDE OF TIN.*

*External characters.* Colours, yellowish brown, brownish black, greyish yellow, hair brown, and nearly colourless, and transparent; the light brown, translucent, and the darker colours, opaque; occurs in crystals, and in masses, from the size of grains to that of the fist; primitive form, the octohedron, with square bases; secondary forms very numerous, but difficult to ascertain, on account of the imperfections, or grouping of the crystals; lustre resinous, or adamantine; structure lamellar; cleavage parallel to the axis of the octohedron, and also to the diagonals of the common base; fracture uneven

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What are the uses of tin?—Is tin ever found in its native state?—What are the colours of oxide of tin?

and imperfectly conchoidal ; gives sparks with steel ; brittle :  
sp. gr. 6.7 to 7.

Fig. 170.



Fig. 171.

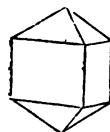


Fig. 172.

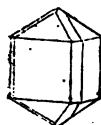


Fig. 173.

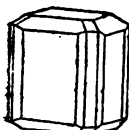


Fig. 174.



Fig. 174. A four-sided prism, surmounted by eight-sided pyramids, which are terminated by four-sided summits.

A great variety of other secondary forms are enumerated.

*Chemical characters.* It decrepitates strongly, but in fine powder may be reduced to the metallic state on charcoal.

*Composition.* Tin 77.5 ; oxygen 21.5 ; oxide of iron 0.25 ; silic 0.75.—*Klaproth.*

*Distinctive characters.* Carbonate of iron, which it most resembles, leaves a magnetic globule under the blowpipe.

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What are the crystalline forms of the oxide of tin ?

Sulphuret of zinc is infusible, and not so hard as oxide of tin; and ferruginous oxide of tungsten, yields readily to the knife, and melts into a black scoria.

Tin occurs only in primitive rocks. Its localities are few, but Jameson observes, that when it does occur, it is generally in considerable quantities.

*Localities.* Cornwall, in England. Gallacia, in Spain. Bohemia, and Saxony. Sumatra, Siam, and Pegu. Mexico and Chili.

The greatest known deposit of tin is at Cornwall, where it occurs in veins, traversing granite, and other primitive rocks, and is associated with chlorite, iron pyrites, topaz, quartz, fluor, &c. The ore from the Cornwall mines is most commonly found in the state of crystals, variously grouped or aggregated, and according to Phillips, the different veins yield different varieties of form. It is also found in alluvial deposits, in the same district, and is called *Stream Tin*, because the ore is separated from the rocks and brought down by streams of water.

Some of the Cornwall mines extend many hundred feet under the sea, and it is said that in one of them, the noise of the waves, and the rolling of the pebbles can be distinctly heard, so near has the excavation been carried to the bottom of the ocean.

The *Block Tin* of commerce is extracted from the ore taken from the excavated mines. *Grain Tin*, which is said to be of a purer quality, is extracted from stream tin.

*Variety 1.* FIBROUS OXIDE OF TIN. WOOD TIN.

*External characters.* Colour, brown, of several shades; occurs amorphous, reniform, globular, and wedge-shaped; surface generally water-worn; structure fibrous in one direction, and concentric lamellar in the other; fibres radiate, or diverge, sometimes intersect each other; lustre feebly resinous; colours, sometimes arranged in bands: sp. gr. 6.4.

*Chemical characters.* Decrepitates, and becomes reddish, but does not melt.

*Composition.* Oxide of tin 91; oxide of iron 9.—Vauquelin.

*Variety 2.* TOAD'S EYE WOOD TIN.

*External characters.* Colours, hair brown, and yellowish white, arranged in concentric layers; occurs in minute

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How is oxide of tin distinguished from other minerals?—Where is the greatest known deposit of tin?

spherical masses, composed of fibres radiating from the centre.

Wood Tin, so called from its fibrous structure resembling that of wood, is found chiefly in the alluvial mining districts of Cornwall. It is commonly found in small masses, but a mass found near St. Austle weighs 15 lb. and for which 100 collars has been offered.

The toad's eye variety, is found in small masses embedded in an aggregate of schorl and quartz.

### Genus 13. ZINC.

Zinc, when pure, is of a brilliant white colour, with a tinge of blue; fracture uneven, striated, or foliated, presenting the result of a confused crystallization; when rubbed on the fingers, zinc imparts to them a peculiar taste and smell. When cold, it is not malleable, but when heated to a little above  $212^{\circ}$  becomes malleable, and may be hammered into thin plates, or drawn under rollers. If heated to about  $400^{\circ}$  it becomes so brittle as to be easily reduced to powder in a mortar.—*Thomson.*

Zinc melts at  $680^{\circ}$ , and if the temperature be increased, it turns of a bluish white flame: sp. gr. 7.29.

*Uses.* When mixed with copper, it forms *brass*, one of the most useful and common of alloys. In chemistry it is employed to obtain hydrogen, by solution with sulphuric acid and water. Its salts and oxides are employed in medicine, and the pure metal, when reduced to thin sheets, is used to cover the roofs of buildings.

Zinc never occurs in the native state, but is found mineralized by sulphur, oxygen, or carbonic acid.

Its ores are few in number, and not common.

### *Species 1.* SULPHURET OF ZINC. *BLÉNDE.*

*External characters.* Colours, yellowish, greenish, reddish, or blackish brown; streak corresponding with the colour, but paler; occurs crystallized, amorphous, and lamelliform; primitive form, the rhombic dodecahedron; secondary forms, the octohedron, and tetrahedron, with their varieties, often modified by truncation and bevelment; opaque, or translucent; yields to the knife; brittle; crystals commonly grouped, so as to make it difficult to determine their forms; lustre shining,

What colour is pure zinc?—How may zinc be made malleable—What are the uses of zinc?—What are the external characters of sulphuret of zinc?

or splendid ; sometimes metallic or adamantine ; structure foliated : sp. gr. 3.7 to 4.

Fig. 175.

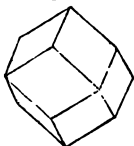


Fig. 175. The rhombic dodecahedron, the primitive form.

Fig. 176.

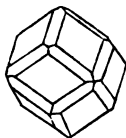


Fig. 176. The same with all the edges truncated.

These simple forms are subject to deep and various truncations ; so that in many instances, the forms are very difficult to determine or understand. One complex form, having the general appearance of fig. 175, is so modified by truncation, as to present 24 faces, of which 12 are nearly equilateral, and 12 isosceles triangles.

*Chemical characters.* Decrepitates, but is commonly infusible. When pulverized and thrown into sulphuric acid, it gives the odour of sulphuretted hydrogen.

*Composition.* (Brown variety.) Zinc 58.8 ; sulphur 23.5 : iron 8.4 ; silice 7.0.—*Thomson*.

(Yellow variety.) Zinc 64 ; sulphur 20 ; water 6 ; iron 5 ; fluoric acid 4 ; silice 1.—*Bergman*.

*Distinctive characters.* Sulphuret of lead is easily reduced to the metallic state by the blowpipe, while the zinc is infusible. Oxide of tin is of a darker colour than the present species, and wants its foliated structure. Chromate of iron tinges borax green, and the carbonate of iron yields a magnetic globule, neither of which characters belongs to zinc.

Zinc is found in primitive and secondary rocks, and is associated with sulphuret of lead, with iron and copper.

*Localities.* Cornwall, and Derbyshire, England, Perthshire, Cumberland, and in the lead hills, near Edinburgh.

U. S. Near Baltimore, Md. Perkiomen lead mine, Penn. Hamburg and Sparta, N. J. Near Hamilton College, N. Y. colour wax yellow and translucent.—*Torrey*. At Shawan-

What are the crystalline forms of blende ?—What are the distinctive characters of blende ?



gunk Mountain, and in the Highlands, N. Y. Berlin, Conn. colour yellow. Southampton lead mine, Mass. Also at Leverett.

This ore commonly occurs too widely disseminated in its gangue, to make it profitable for working. It is however sometimes, after roasting, used in the preparation of brass.

*Species 2.* RED OXIDE OF ZINC.

*External characters.* Colours, ruby, blood, or aurora red, sometimes yellowish red; occurs massive, and disseminated; fracture foliated in one direction, and flat conchoidal in the other; lustre shining, and somewhat micaceous; cleavage, (according to Phillips,) parallel to all the planes of a regular six-sided prism; translucent on the edges; by exposure, becomes dull, and covered with a whitish pearly crust; structure foliated; brittle, and easily reduced to powder; yields to the knife: sp. gr. 6.22.

*Chemical characters.* Infusible alone, but with borax yields a yellowish transparent bead. Soluble with effervescence, in all the mineral acids; with potash melts into an emerald green glass, which communicates to water, the same colour, but is changed to rose red, on the addition of a few drops of acid.—Bruce.

*Composition.* Zinc 76; oxygen 16; oxides of manganese, and iron 8.—Bruce.

Oxide of zinc 88; red oxide of manganese 12.—Berthier.

*Distinctive characters.* It differs from red sulphuretted antimonial silver, and from the chromate of lead, by its infusibility before the blowpipe; from the red oxide of copper by its greater specific gravity, and by its colourless solution in nitric acid; from the red oxide of titanium, by its solubility in acids; and is not like the red sulphuret of arsenic, volatilized by the blowpipe, with the garlic odour.—Cleaveland.

*Localities.* In the Franklin, Stirling, and Rutger's iron mines, in Sussex County, N. J. At Franklin, it is embedded in a whitish oxide of zinc. Sometimes the Franklinite is embedded in it, forming an aggregate of a singular aspect, a red ground, with black spots.

Cleaveland remarks, that this ore is well adapted to the manufacture of brass.

*Species 3.* SILICIOUS OXIDE OF ZINC.

*External characters.* Colours, yellowish or greyish white,

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What are the external characters of the red oxide of zinc?—What are the distinctive characters of red oxide of zinc?

and light brown, sometimes with a tinge of green ; occurs stalactical, botryoidal, massive, and crystallized ; primary form the right rhombic prism ; secondary forms the six-sided prism, and the four-sided table, variously modified by truncation ; also the octohedron ; crystals commonly collected into groups ; translucent or transparent ; becomes electric by heat ; sometimes gives fire with steel, but may more commonly be scratched by the knife ; texture, foliated, fibrous, or earthy : sp. gr. 3.4.

*Chemical characters.* Whitens, and becomes friable, but does not melt. Dissolves in nitric acid, without effervescence, forming a gelatinous solution.

*Composition.* Oxide of zinc 66 ; silic 33.—*Klaproth.*

Oxide of zinc 38 ; silic 50 ; water 12.—*Pelletier.*

*Distinctive characters.* The zeolites, which it sometimes resembles, melt into a spongy mass. From stilbite, and the varieties of carbonate and sulphate of lime, it is distinguished by the effects of acids, and the result of the blowpipe, as also by its electric property.

This species is found in primitive, transition and secondary rocks, but most frequently in limestone.

*Localities.* Wanlockhead, in Scotland. Leicestershire, and Derbyshire, Eng. Flintshire, in Wales. Bleiberg, in Carinthia, and Friberg, in the Brisgau.

U. S. Perkiomen lead mine, and at Conestoga creek, Penn. Near the falls of the Hockhocking, Ohio.

*Species 4. CARBONATE OF ZINC. CALAMINE.*

*External characters.* Colours, grey, greenish, or brown yellowish, and sometimes nearly white ; occurs crystallized, compact, amorphous, pseudo-morphous, and cupriferous ; translucent, or opaque ; yields to the knife ; not electric by heat : sp. gr. 3.35 to 4.41.

*Chemical characters.* Infusible, but loses about 34 per cent. by ignition. Soluble with effervescence, in cold sulphuric, or warm nitric acid. Cleaveland says, if paper, which has been immersed in a solution of this salt, in nitric acid, be dried, and then held at the distance of a few inches from burning coals, it spontaneously kindles.

*Distinctive characters.* It is distinguished from the silicious

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What are the colours of silicious oxide of zinc ?—What are the distinctive characters of the silicious oxide of zinc ?—What are the colours of carbonate of zinc ?—What are the chemical characters of carbonate of zinc ?

oxide, by its effervescence with acids, and by its not forming a gelatinous solution.

*Uses.* When melted with copper it forms *brass*.

The two last named species were anciently known under the name of *calamine*.

The ancients highly esteemed an earth under the above name, which had the quality of converting copper into a golden yellow metal, and at the same time, of increasing its weight.

It is most probable, that at first, brass was formed by the natural occurrence of the ores of copper and zinc together, as is said to be the case in some of the Hungarian mines.

Brass had been made and employed in the arts, for many centuries, before it was known that calamine, which was considered an earth, contained a metal.

At present, most of the brass used in commerce and the arts, is made more or less after the ancient manner. The oxide, or carbonate of zinc, being previously roasted, is mixed with granulated copper and charcoal, and then exposed to a proper degree of heat. The zinc is reduced to its metallic state, and unites with the copper to form the alloy in question.

The mode of obtaining metallic zinc, is by first roasting the calamine to drive off the carbonic acid, and other volatile matters, and then by distilling, in earthen retorts, the beaks of which are placed under water. The metal passes by distillation, into the vessels of water. This process is said to have been obtained from the Chinese, by a person who went out for that purpose.

#### *Species 5.* SULPHATE OF ZINC.

*External characters.* Colours, white, greyish, or reddish white; occurs in concretions, in efflorescences, stalactical, reniform, and investing; also crystallized in minute rectangular, four-sided prisms; structure of the massive, fibrous and radiated; lustre shining; translucent; soft, brittle; soluble in water; taste, styptic and nauseous: sp. gr. 2.

*Chemical characters.* Before the blowpipe it fuses, and gives off a large quantity of water and sulphuric acid, leaving a grey scoria. Its solutions in water, are precipitated into the carbonated alkalies.

*Composition.* Oxide of zinc 27.5; sulphuric acid 22; water 50.

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What is calamine?—What was the ancient method of making brass?  
—How is metallic zinc obtained?—What is the composition of white vitriol?



It is found in mines, containing the sulphuret of zinc, from the decomposition of which it is supposed to arise.

The sulphate of zinc, or *white vitriol* of commerce, is produced by the same kind of process, already described, for making green vitriol, or sulphate of copper. The sulphuret of zinc, being first roasted, is exposed to the action of the air and moisture, by which means the sulphur is converted into sulphuric acid, by the absorption of oxygen from the atmosphere. As the acid forms, it combines with the zinc, forming a sulphate, which is obtained by lixiviation, or washing, and subsequent evaporation and crystallization.

#### Genus 14. MANGANESE.

Manganese, in its metallic state, has not been converted to any use; it is therefore never reduced, except in the laboratory of the chemist, in small quantities, by way of experiment.

When pure, it is of a greyish white colour, like cast iron, and of a brilliant lustre; melts at 160° Wedgewood, and has neither taste, nor smell. Exposed to the air, it soon loses its lustre, and again becomes an oxide: sp. gr. 8.

*Uses.* The black oxide of manganese is employed, with muriate of soda, and sulphuric acid, to produce chlorine, a gas used in bleaching cotton and linen cloth, paper, &c. It is also used with sulphuric acid, to furnish oxygen gas for chemical purposes; and in small quantities, it enters into the composition of glass. It is also employed to give a purple tinge to enamel.

The best test of the presence of manganese is the purple colour which all its ores give, when fused with borax.

The ores of this metal are not very numerous, but they are widely disseminated, and quite common.

#### Species 1. BLACK OXIDE OF MANGANESE.

*External characters.* Colours, greyish black, dark violet, or iron black; occurs massive, acicular, and crystallized; primitive form, the rhombic prism, with various modifications; also, in acicular crystals, longitudinally striated, and diverging, or confusedly intersecting each other; lustre earthy, sometimes metallic, and shining; soils the fingers: sp. gr. 4.14 to 4.80.

#### Variety 1. RADIATED AND FIBROUS BLACK OXIDE OF MANGANESE.

*External characters.* Colour, dark steel grey, passing into

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How is white vitriol prepared?—What are the uses of the black oxide of manganese?—Are the ores of manganese common ores, or not?—What are the external characters of black oxide of manganese?

iron black ; occurs in fibres, or in acicular crystals, sometimes radiating from a point, and sometimes intersecting each other in various directions, and resembling a bunch of the finest steel needles, after having been in the fire ; lustre metallic ; often presenting specimens of singular beauty.

*Chemical characters.* Infusible alone, but with borax dissolves, giving the globule a dark violet, or purple tinge. When a grain or two of its powder is mixed with a little common salt, and moistened with sulphuric acid, and heated, the suffocating smell of chlorine is emitted.

*Composition.* Manganese 44 ; oxygen 42 ; oxide of iron 3 ; silic 5 ; carbon 1.5.—*Cordier.*

Oxide of manganese 99.25 ; water 0.25.—*Klaproth.*

*Distinctive characters.* It resembles sulphuret of antimony, but this is easily fusible, while the manganese is infusible. It may be confounded with brown hæmatite, but this becomes magnetic under the blowpipe, and tinges borax brown, while the manganese tinges borax purple.

#### Variety 2. COMPACT BLACK OXIDE OF MANGANESE.

*External characters.* Colours, dark steel grey, passing into iron black, violet brown, or brownish black ; occurs massive, stalactical, and botryoidal ; lustre a little metallic, or dull ; fracture conchoidal, or uneven ; texture compact ; yields to the knife, but sometimes scratches glass ; soils the fingers : sp. gr. 3.70.

*Chemical characters.* Infusible alone ; with borax gives the purple globule.

*Composition.* It is an impure mineral, containing about 60 or 80 per cent. of the oxide of manganese, 20 per cent. of iron, and often a portion of silic, barytes, carbon, &c.

#### Variety 3. EARTHY OXIDE OF MANGANESE.

*External characters.* Colours, greyish brown, and blackish brown ; occurs massive, amorphous and botryoidal ; texture and fracture earthy ; more or less friable, and sometimes pulverulent ; soils the fingers strongly : sp. gr. 2 to 3.

*Composition.* It sometimes contains nearly one half oxide of iron, or other foreign substances.

This variety is known to miners under the name of *wad*. Jameson says, that when it is dry, and mixed with one fourth of its weight of linseed oil, and moderately heated, it inflames.

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What are its chemical characters ?—What is the composition of black oxide of manganese ?—What are its distinctive characters ?

Oxide of manganese is found chiefly in primitive rocks, and most frequently among the ores of iron. It is very extensively diffused, and is often the colouring matter of other minerals. It however does not very often occur in large quantities at a place.

*Localities.* Cornwall, Devonshire and Aberdeen. In Germany, France, Siberia, and indeed in almost every country.

U. S. Lawrence county, Arkansas Territory. Near Greenburg, and near Big Sandy river, Ken. Shenandoah county, and Albemarle county, Virg. Near Wilkesbarre; also near Lancaster, and in Northumberland county, Penn. Near Hamburg, N. J. Near Troy and near Ancram, and on the Island of New York, N. Y. Monkton, Ver. crystallized and earthy. Also at Bennington, from whence large quantities are drawn for use.—*Hall*. Lebanon, Conn. Milton, Lynn, Deerfield, and Leverett, Mass. Also at Dorchester, Adams, Richmond and Plainfield, Mass.

*Species 2.* SILICIOUS OXIDE OF MANGANESE.

*External characters.* Colours, pale red, rose red, reddish brown, and yellowish white; occurs massive, composed of granular concretions; also earthy, and it is said in lenticular crystals; fracture conchoidal; lustre shining, or nearly dull; scratches glass, when compact: sp. gr. 3.2.

*Chemical characters.* Fusible on the edges; with borax, gives a violet coloured, translucent glass.

*Composition.* Oxide of manganese 52.6; silic 39.6; oxide of iron 4.6; lime 1.5; volatile matter, 2.75.—*Berzelius*.

*Localities.* Kapnic, in Transylvania, with magnetic oxide of iron, and garnets. Near Tavistock, in Devonshire, with the grey oxide of manganese. Also in Sweden, Siberia, &c.

U. S. Middlebury, Ver. Cummington, Mass.

*Species 3.* CARBONATE OF MANGANESE.

*External characters.* Colours, rose red, reddish white, and brownish; occurs massive, composed of small shining crystalline grains, of a foliated structure; also globular, and reniform; yields a little to the knife; translucent on the edges; fracture conchoidal, and splintery: sp. gr. 3.20.

It is said also to occur in lenticular crystals.

*Chemical characters.* Infusible, but becomes brown; with borax, gives a reddish violet bead.

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What are the external characters of silicious oxide of manganese?—  
What are the colours of carbonate of manganese?

*position.* Oxide of manganese 48 ; carbonic acid 49 ; of iron 2.1 ; silic 0.9.—*Lampidius.*

*localities.* Nagyag, and Kapnic, in Transylvania, in a vein of auriferous tellurium.

*Genus 15. MOLYBDENA.*

pure metal, which is obtained with great difficulty, is of a blue colour, tinged with yellow. On exposure to the air, it oxidates, but remains unaltered under water. On exposure to continued heat, it is converted into a white oxide. On the action of sulphuric and nitric acid, it is converted into molybdic acid, which has the form of a yellowish white powder. Sp. gr. of the pure metal, 8.6.

Ores of this metal are few, and though not uncommon, are rarely occur in any considerable quantities.

*Species 1. SULPHURET OF MOLYBDENA.*

*Physical characters.* Colour, nearly that of fresh cut, metal; occurs massive, or crystallized, in short hexahedrons; structure lamellar, or foliated; cleavage perfect in one direction; lustre brilliant, and not subject to tarnish; easily separable, and somewhat flexible; unctuous to the touch; leaves a metallic streak on paper; opaque; sp. gr. 4.7; often appears, in spots, or dots, in other minerals, and in limestone.

*Chemical characters.* Infusible, but sometimes gives out a little sulphur, and if the heat be urged, emits white fumes. Soluble with effervescence in carbonate of soda. It is converted into molybdic acid by the action of nitric acid.

*Composition.* Molybdena 60 ; sulphur 40.—*Bucholz.*

*Diagnostic characters.* It resembles plumbago, but may be easily, and certainly distinguished from it, by the blowpipe test. The molybdena, in small scales, will adhere to the surface of the globule of fused borax, without any change; but plumbago dissolves, or separates into minute particles, coating the surface of the borax with a lead grey crust. Magnetic iron becomes magnetic before the blowpipe, which always distinguish it from molybdena.

This mineral belongs to primitive rocks, as granite, gneiss, and primitive limestone.

*Localities.* Near Mont Blanc. Near Norberg, in Sweden,

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What is said of pure molybdena?—Are the ores of molybdena common?—What is the appearance of sulphuret of molybdena?—What are the chemical characters of this ore?—How is this ore distinguished from plumbago?

in a white steatite. Abo, in Finland, with hornblende. Chessy, in France, in scienite. Cornwall, with tin and copper. Cumberland, with apatite, and iron ore.

U. S. Chester county, and Delaware county, Penn. Near Baltimore, in granite. Near Philadelphia, in gneiss. On the island of New-York, and in the Highlands, N. Y. Also in West Chester, and Putnam counties, and at Crownpoint. East Haddam, Saybrook, and Brookfield, Conn. Shaftsbury, Mass. in six-sided tables or plates.—*Silliman*. Also, at Brimfield. Brunswick, Maine, in six-sided tables, and in foliated masses.—*Cleaveland*.

*Species 2. OXIDE OF MOLYBDENA.*

*External characters.* Colour, straw, or sulphur yellow; occurs pulverulent, and in friable crusts.

*Chemical characters.* When heated, by the compound blowpipe, a snow white oxide is sublimed.—*Cleaveland*.

It has not been analyzed, but according to the observation of Berzelius, it behaves under the blowpipe like pure molybdic acid.

*Localities.* Nummedalen, in Norway, on sulphuret of molybdena. And at Coryburg, in Scotland.

U. S. Brunswick, in Maine, with sulphuret of molybdena.

*Genus 16. ANTIMONY.*

Colour of the pure metal, white; occurs in foliated or lamellar masses, the lamellæ being placed in irregular directions, often with broad shining faces, sometimes curved; brittle, and easily reduced to a powder; melting point 800° Fah. and at a higher heat, evaporates in form of a grey smoke; soluble in the acids: sp. gr. 6.8.

*Uses.* It enters into the composition of printing types, of speculum metal, of Britannia ware, &c. In medicine it is universally employed, when united to tartaric acid, under the name of *tartar emetic*.

Its ores are few, and its localities not very numerous.

*Species 1. NATIVE ANTIMONY.*

*External characters.* Colour, tin white, but on exposure becomes yellowish, or brownish; occurs reniform, amorphous, and in thin plates; also crystallized in octohedrons, and dodecahedrons; lustre brilliant; structure lamellar;

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What is the colour of pure antimony?—Is antimony a brittle, or a malleable metal?

cleavage easily effected, in certain directions ; brittle : sp. gr. 6.7.

*Chemical characters.* Easily fusible with a grey inodorous vapour. With borax, it separates into small individual globules, and continues to emit white fumes from its own combustion, after the heat is removed ; on cooling, the globule becomes covered with minute crystals of the oxide of antimony.

*Composition.* Antimony 98 ; silver 1 ; iron 0.25.—*Klaproth.*

It often contains a little arsenic, and some specimens leave a small globule of silver on the charcoal, after the antimony has escaped.

*Distinctive characters.* It resembles antimonial silver, but this always yields a globule of silver under the blowpipe. The sulphuret of antimony gives the odour of sulphur, which the native does not. It may also be taken for arsenical iron, and native bismuth. But the first emits the arsenical odour, and leaves a magnetic globule, and the bismuth has a tinge of copper-red.

It is found in primitive rocks, and is a rare ore.

*Localities.* Sahlberg, in Sweden. Dauphiny, in France. Andreasberg, in the Hartz. Allemont, near Grenoble.

U. S. Harwinton, Conn. in broad plates, associated with sulphuret of antimony.—*Silliman.*

#### *Species 2.* SULPHURET OF ANTIMONY.

*External characters.* Colour, lead grey, passing into steel grey ; streak unchanged ; often iridescent, from external tarnish ; occurs massive, composed of delicate threads, or needles, closely aggregated, and sometimes so fine as to resemble wool ; also, crystallized in rhombic prisms, variously modified, and variously terminated ; lustre splendid ; fracture, and texture fibrous ; yields to the knife ; brittle, and easily reduced to powder : sp. gr. 4 to 4.80.

*Chemical characters.* Melts in a candle. Before the blowpipe, emits the odour of sulphur, and is mostly volatilized, in the form of a white smoke.

*Composition.* Antimony 74 ; sulphur 26.—*Bergman.*

*Distinctive characters.* The easy fusibility of this species,

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What are the chemical and distinctive characters of native antimony ?  
—What are the uses of antimony ?—What are the colours of sulphuret of antimony ?

will easily distinguish it from the minerals it most resembles, particularly, from the oxide of manganese. It differs from native antimony, in emitting the sulphureous odour when heated, and in being of a darker colour.

Sulphuret of antimony is the ore from which the antimony of commerce is obtained. It is found in primitive and secondary rocks, associated with the sulphurets of lead, and zinc, and with ores of iron, copper, and arsenic.

*Localities.* Andreasberg, in the Hartz. Friberg, in Saxony. Schemnitz, in Hungary. Nagyag, in Transylvania. Mexico. England. Scotland. Ireland. Spain, &c.

U. S. Near Richmond, in Virg. Near Zanesville, Ohio. Harwinton, Conn. with native antimony. Near South Hadley, Mass. On Saco river, Maine.

### *Species 3.* SULPHURETTED OXIDE OF ANTIMONY.

*External characters.* Colour, cherry red, or brownish red, streak unchanged; surface, often iridescent, from tarnish; occurs in acicular prisms, radiating, or interlacing; feebly translucent; also, occurs massive, with a fibrous, or granular structure; lustre metallic adamantine; brittle: sp. gr. 4 to 4.6.

*Chemical characters.* Melts easily, and is entirely volatilized, by continuing in the heat. In nitric acid, it becomes covered with a white coating, but does not entirely dissolve.

*Composition.* Antimony 67.50; oxygen 10.80; sulphur 19.70.—*Klaproth.*

It occurs with the sulphuret of antimony, which has induced a belief, that it arises from the decomposition of that ore.

*Distinctive characters.* Cinnabar is of a deeper, or scarlet red colour, and is volatilized with a blue flame. Red oxide of copper leaves a globule of the metal on the charcoal, and the red oxide of tin is infusible.

*Localities.* Kapnic, in Transylvania. Allemont, in France. Hungary. Saxony. Tuscany, &c.

U. S. Near Leesburg, Vir. in detached masses, in the soil; it has a deep ruby colour.—*Hayden.*

### *Genus 17.* CHROME.

Colour of the pure metal, between tin white, and steel grey. It is obtained from the native chromate of iron, with difficulty,

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What are its distinctive characters?—What is the ore from which the antimony of commerce is obtained?—What are the colours of sulphuretted oxide of antimony?—What are the chemical characters of this ore?

and only in small quantities ; when this metal is oxidated to its fullest extent, it constitutes chromic acid, a crystalline solid of a beautiful aurora red colour. The metal has a radiated, crystalline texture, and is hard, and brittle : sp. gr. about 6.

*Uses.* The oxides of chrome, or chromic acid, form very beautiful and useful colours, when combined with other metals, as iron, cobalt, lead, or mercury. Green, yellow, and red colours, are produced in this way, and are employed as pigments, and for the colouring of porcelain ware. The emerald, actinolite, and several other green minerals, owe their colours to oxide of chrome.

*Species 1.* OXIDE OF CHROME.

*External characters.* Colours, bright grass green, and pale yellow ; occurs pulverulent, or compact ; translucent, when compact, and of a green colour, bearing the marks of crystalline structure ; lustre, and appearance, like that of compact crystalline limestone.

*Chemical characters.* The green changes to yellow by heat. Gives a green colour to borax, and also to boiling alkali ; but the colour is precipitated by further boiling.

*Locality.* Unst, one of the Shetland isles, where it fills the cavities of chromate of iron.—*Mac Culloch.*

*Genus 18.* ARSENIC.

Colour of the metal, bluish white, like that of steel ; lustre brilliant ; brittle ; soft ; may be reduced to powder in a mortar ; when heated it emits the odour of garlic, and flies off in white fumes ; sublimes without melting ; oxidates, and turns dark, on exposure, but retains its brilliancy for years, if closely sealed in a glass tube : sp. gr. 5.7.

*Uses.* It enters into the composition of some metallic alloys, and its oxides are employed in the preparation of certain paints ; in the colouring of glass, and in medicine, it is used under the name of *Fowler's solution*. It is a violent poison, in all its modes of existence, except in that of a pure metal.

No mines are wrought for the purpose of obtaining this metal. That used in commerce, which is the white oxide, is chiefly scraped, by condemned criminals, from the long chimnies of the cobalt smelting furnaces in Saxony.

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What is said of metallic chrome ?—What are the uses of the oxides of chrome ?—What is the colour of the native oxide of chrome ?—What are the chemical characters of the native oxide of chrome ?—What is the colour of pure arsenic ?—What are the uses of arsenic ?



*Species 1. NATIVE ARSENIC.*

*External characters.* Colour, tin white, inclining to steel grey, or lead grey; externally, tarnished nearly black; occurs reniform, botryoidal, in plates, and in concretions; fracture uneven; structure imperfectly foliated; or sometimes, concentric lamellar, and sometimes, with impressions of crystals; yields to the knife; brittle; lustre metallic: sp. gr. 5.7.

*Chemical characters.* Burns with a blue flame, yielding a dense white smoke, attended with the odour of garlic, and leaves on the charcoal, a minute portion of iron, silver, or gold.

*Distinctive characters.* From other native metals, it may readily be distinguished, by its beginning to evaporate before it melts. Arsenical pyrites leave a magnetic globule; and arsenical antimonial silver, leaves a silver globule, both of which will show that they are not the present species.

It occurs chiefly in primitive rocks, with the ores of cobalt, silver, copper, &c.

*Localities.* Koningsberg, in Norway. In the Hartz. Bohemia. France. England, &c.

U. S. Martha's vineyard.

*Species 2. OXIDE OF ARSENIC.*

*External characters.* Colour, snow white, or yellowish, reddish, or greenish white; occurs earthy, capillary, and investing; also crystallized in octohedrons, and in quadrangular tables; cleavage parallel to the planes of the octohedron; lustre vitreous; texture fibrous, or granular; crystals often minute and delicate; translucent; opaque.

*Chemical characters.* Gives out the smell of garlic, and finally evaporates. Soluble in about 80 parts of water.

*Distinctive characters.* Its solubility in water will distinguish it from pharmacolite, and other minerals which it resembles.

*Localities.* Andreasberg, in the Hartz, with the ores of arsenic and lead. Also in the Pyrenees.

This is a very rare mineral, and perhaps, with the exception of the carbonate of barytes, which is also rare, the only instance, where nature has furnished, ready prepared, a violent poison in the mineral kingdom.

*Species 3. SULPHURET OF ARSENIC.*

Of this species there are two varieties, which differ chiefly in respect to colour. They are both composed of metallic

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What are the distinctive characters of native arsenic?—What is said of the properties of the native oxide of arsenic?

arsenic, and sulphur, though probably in different proportions.

*Variety 1. RED SULPHURET OF ARSENIC. REALGER.*

*External characters.* Colour, aurora red, scarlet, or blood red; occurs amorphous, in concretions, and in flakes, or crusts; also crystallized in the form of a four-sided prism, with the terminal planes set obliquely on the lateral planes, and in six-sided prisms, both forms being subject to a variety of modifications, from truncation, and bevelment; lustre shining, vitreous, or waxy; streak, lemon yellow; fracture of the compact, conchoidal; semi-transparent, or opaque; soft; often yields to the nail; brittle: sp. gr. 3.30; becomes electric, by friction.

*Chemical characters.* Melts easily, and burns with a blue flame, and white smoke, attended with the odours of sulphur and garlic. In nitric acid, it becomes whitish.

*Composition.* Arsenic 69; sulphur 31.—*Klaproth.*

*Distinctive characters.* Its colour resembles that of chromate of lead, but the chromate is much heavier, and tinges borax green. The red ores of silver and mercury give a red streak, and seldom give the odour of arsenic, like the present variety. They are also heavier than the present species.

*Uses.* It is employed as a paint, and the Chinese form vessels, and images of it.

*Variety 2. YELLOW SULPHURET OF ARSENIC. ORPIMENT.*

*External characters.* Colour, lemon, or golden yellow; occurs reniform, disseminated, and in plates; also, it is said, in minute crystals; lustre shining, sometimes brilliant, and metallic; structure foliated, or laminated, the laminæ often curved, and easily separable, like those of mica; flexible, but not elastic; translucent; by friction acquires negative electricity: sp. gr. 3.4.

*Chemical characters.* Burns, emitting the fumes of sulphur and arsenic.

*Composition.* Arsenic 57; sulphur 43.—*Thenard.*

*Distinctive characters.* It most resembles yellow mica, but the layers of mica are flexible and elastic; those of orpiment being easily broken. Mica also gives no fumes when heated. Native sulphur has not a foliated structure, like orpiment, and is not so heavy.

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What are the colours of the red sulphuret of arsenic?—What are the distinctive characters of realger?—What are the external and distinctive characters of orpiment?

*Uses.* Orpiment is employed as a paint, but for this purpose, it is mostly prepared by art.

Both varieties are found, chiefly in secondary, but sometimes in primitive rocks. Sometimes realgar occurs among the products of volcanoes.

*Localities.* Realgar is found in the Hartz, in the mines of Saxony, Bohemia, and Hungary, and on the North West coast of America. Also, among the volcanic matter of Etna, Vesuvius and Guadaloupe.

Orpiment is also found in Suabia, in Piedmont, at Moldavia, in Hungary, in China, and in Nova Scotia, in America.

#### *Genus 19. COLUMBIUM.\**

Columbium, in the purest state in which it has been obtained, is a metal of a dark iron grey colour, which, when rubbed against a fine whetstone, or is scratched with a knife, puts on the metallic lustre. It scratches glass, is brittle, and is not acted on by any of the acids, or by any mixture of them : sp. gr. 6.

The ores of Columbium are few, and occur but rarely, and in small quantities.

#### *Species 1. FERRUGINOUS OXIDE OF COLUMBIUM.*

*External characters.* Colours, greyish, and brownish, or bluish black ; occurs amorphous, and in small crystalline masses, the forms of which are imperfect, four, and six-sided prisms, sometimes flattened, and variously modified by truncation ; structure imperfectly foliated ; brittle ; lustre a little shining, but not metallic ; opaque : sp. gr. 6 to 7.

*Chemical characters.* Infusible, and suffers no change by the blowpipe alone. Partly soluble in heated sulphuric acid.—*Mohs.* If fused with potash, mixed with a little borax, the mass spreads on the charcoal, and passes from a brownish to a greenish colour. With borax it dissolves with difficulty, and forms a bottle green glass.

*Composition.* (From New-London.) Oxide of columbium 87 ; oxide of iron 21.—*Hatchett.*

(From Sweden.) Oxide of columbium 85 ; oxide of iron 12 ; oxide of manganese 8.—*Vauquelin.*

Columbium was first discovered by Mr. Hatchett, in a specimen of unexamined ore, said to have been sent from Gov.

\* From its being first discovered in America.

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What are the uses of these two ores ?—What are the external and chemical characters of ferruginous oxide of columbium ?—Where was columbium first discovered ?

Winthrop, of Connecticut, to Sir Hans Sloane. It was deposited in the British Museum, and analyzed by Mr. Hatchett, in 1801, who found that it was the ore of a new metal, to which he gave the name of *Columbium*, in honour of this country.

After the discovery of Mr. Hatchett, Mr. Ekeberg, a Swedish chemist, discovered the oxide of a new metal, in a specimen of ore from Finland, and to which he gave the name of *Tantalum*. The ore itself he called *Tantalite*.

In the year 1809, Dr. Wollaston, having obtained specimens of the ores of the two new metals from America, and from Finland, discovered that they differed only in respect to localities, and that they were ores of the same metal.

*Localities.* Kemito, in Finland. Bodenmais, in Bavaria.

U. S. New-London, and Haddam, Conn. At Haddam, it is embedded in granite, with garnet, chrysoberyl, and beryl.—Torrey. Warwick, N. Y.—Robinson.

#### *Genus 20. CERIUM.\**

The characters of this substance, as a pure metal, are little known. The chemists have demonstrated, that such a metal exists, but its refractory nature is such, as to defy every means, heretofore used, to reduce it to the state of a pure metal.

Its ores are various, but most of them are rare, and have been found in only small quantities.

#### *Species 1. SILICIOUS OXIDE OF CERIUM.*

*External characters.* Colours, rose red, brownish red, and flesh red, passing into grey; streak nearly white; occurs massive and disseminated; fracture compact; splintery; translucent, or opaque; brittle; texture granular; lustre shining; scratches glass; yields with difficulty to the knife: sp. gr. 4.9.

*Chemical characters.* Infusible alone; with borax dissolves into an orange coloured globule, which grows pale on cooling.

*Composition.* Oxide of cerium 68.59; silice 18; oxide of iron 2; lime 1.25; water and carbonic acid 9.60.—Heisinger.

*Locality.* Westmoreland, in Sweden, with bismuth, mica, hornblende, and molybdena.

\* From the planet Ceres.

*Species 2. ALLANITE.\**

*External characters.* Colours, brownish, and greenish black; powder greenish grey; occurs massive, and crystallized in four, and six-sided prisms, variously terminated; fracture imperfect conchoidal; lustre shining resino-metallic; scratches glass, and gives sparks with steel; opaque: sp. gr. 3.5 to 4.

*Chemical characters.* Becomes greenish yellow, and sometimes intumesces, and melts into a slag.

*Composition.* Oxide of cerium 33; oxide of iron 25.40; siliceous 35.40; lime 9.20; alumina 4.10.—*Thomson.*

*Distinctive characters.* It resembles gadolinite, but according to Bournon, gadolinite, in thin pieces, is translucent, and of a fine green colour, while the present species is commonly opaque, but when translucent, is of a yellowish brown colour.

*Locality.* West Greenland, in a granite rock.

*Species 3. ITTRIO-CALCAREOUS OXIDE OF CERIUM.*

*External characters.* Colours, greyish white, greyish red, and violet blue; colours sometimes mingled in the same specimen; occurs amorphous, and in crusts; texture granular; structure lamellar; lustre glistening; fracture uneven; yields to the knife: sp. gr. 3.44.

*Chemical characters.* Becomes white, but is infusible alone. On adding a little gypsum, it fuses into a bead, which becomes white on cooling. In fine powder, soluble in muriatic acid, forming a yellow solution.

*Composition.* Oxide of cerium 18.22; ittria 9.11; lime 47.63; fluoric acid 25.—*Berzelius.*

*Localities.* Finbo, in Sweden, disseminated in quartz.

U. S. Franklin, N. J. discovered by Col. Gibbs.—*Siliman.*

*Species 4. FLUATE OF CERIUM.*

*External characters.* Colours, yellow, pale red, or deep red; occurs in small masses, in plates, and in six-sided prisms; soft, some of the varieties yielding to the nail.

This is not quite a pure fluuate, but contains a little ittria, or thorina.

\* In honour of Thomas Allen, Esq. of Edinburgh.

*Genus 21.—TITANIUM.*

This metal has hardly been seen in its pure metallic state. Laviolle exposed its oxide, mixed with combustible matter, to the highest heat of a forge for six hours, when a mass full of pores was obtained. This he considered metallic titanium. It was brittle, with a bright lustre, and in thin pieces, elastic : sp. gr. unknown.

The ores of titanium, are considerably numerous, and are widely disseminated.

No use has yet been made of any of them.

*Species 1. OXIDE OF TITANIUM.*

*External characters.* Colours, red, reddish brown, yellowish red, and reddish grey ; also, indigo blue, pale blue, and dark red ; occurs massive, but more commonly crystallized in octohedrons, or in prismatic crystals, imperfectly terminated ; fracture granular, or uneven, in one direction, and laminated in another ; texture foliated ; lustre metallic, or adamantine ; opaque, or translucent ; scratches glass : sp. gr. 3.8 to 4.24.

*Chemical characters.* Infusible alone ; with borax, melts into a transparent globule, either reddish, or tinged with various colours, according to the proportion of borax.

*Composition.* Titanium 66.05 ; oxygen 33.95.—*Rose.*

It is a pure oxide of titanium.

*Variety 1. RED OXIDE OF TITANIUM.*

*External characters.* Colours, red, reddish brown, or copper red, sometimes grey on the surface ; occurs crystallized, in four, six, or eight-sided prisms, sometimes terminated by four-sided pyramids, and sometimes with rounded terminations ; crystals, often long, straight, acicular, and striated ; also occurs, in minute, reticulated crystals ; and in bent, or geniculated prisms ; structure lamellar ; lustre adamantine, or metallic ; fracture conchoidal, or uneven ; translucent ; scratches glass ; brittle : sp. gr. 4.24.

Fig. 177.



Fig. 177. A geniculated crystal, or two crystals, united base to base, forming an obtuse angle, or knee. In other respects, there is nothing peculiar in the prisms which this variety presents.

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What is said of titanium as a metal ?—What are the colours of the oxide of titanium ?

*Chemical characters.* Infusible by itself; with borax, melts into a reddish transparent glass.

*Composition.* It is a pure oxide of titanium.—*Klaproth.*

*Distinctive characters.* It differs from the silico-calcareous oxide of titanium, in being more transparent, in occurring in more perfect crystals, and in being harder. It resembles the red garnet, but this is fusible alone. The oxide of tin has a greater specific gravity, and decrepitates strongly when heated.

Titanium, in connexion with some other substances, often forms very beautiful specimens.

The *reticulated* variety, composed of capillary or acicular crystals, is found investing, or penetrating other minerals. Sometimes it shoots through limpid pieces of quartz, the crystals crossing each other, and forming a kind of net-work; hence the name, *reticulated*. Such specimens, when polished, sometimes display the crystals of titanite, of the size of needles, or even hairs, of a blood red colour, and appearing as though they were shot into their places, when the quartz was perfectly soft. Some of these specimens are singularly curious and beautiful.

Titanite occurs chiefly in veins, in primitive rocks, and particularly in granite, gneiss, and quartz.

*Localities.* St. Gothard, often reticulated in quartz. Taormina, in spathose iron. Carpathian mountains, in Hungary. Arendal, in Norway. Cairngorm, in Scotland. Fernbo, near Sala, in Sweden.

U. S. Near Richmond, Vir. compact, blood red, in white quartz.—*Bruce.* Also in the counties of Randolph, Amherst, Campbell, and Bedford, Vir. At some of these places, fine specimens are found, some of which are near four inches long.—*T. D. Porter.* Near Baltimore, Md. London Grove, Chester county, Penn. Also, in Delaware county, and at East Marlborough. Bergen county, near Schuyler's copper mine, N. J. embedded in limestone. Its lustre is highly metallic.—*Bruce.* Near New Haven, and at Oxford, and Litchfield, Conn. At Oxford, it is geniculated, and at Litchfield, it is sometimes reticulated. Worthington, and Leyden, Mass. At Leyden, the crystals are four and eight-sided prisms. Near Kingsbridge, and on Hudson river, N. Y. colour, from dark blood red to light red, sometimes geniculated, and sometimes acicular.—*Bruce.*

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What are the distinctive characters of titanium?

**Species 3. SILICO-CALCAREOUS OXIDE OF TITANIUM. SPHENE.**

*External characters.* Colours, reddish grey, lilac grey, chestnut brown, and blackish grey; colours dull; also greenish, yellowish green, and greenish white; occurs in masses, composed of angular, prismatic pieces, with distinct joints, easily separable; and in crystals, of which the primary form is an oblique, rhombic prism; secondary forms numerous; viz. an oblique angled, four-sided prism, with an uncertain number of terminal faces; sometimes this prism is bevelled on the lateral angles, and sometimes on the angles of the extremities; sometimes the crystals are compressed into cuneiform shapes, and sometimes by truncation they take nearly a hexahedral form; structure foliated, with broad, smooth faces; lustre shining, but scarcely metallic; cleavage easy; cross fracture uneven; translucent on the edges; crystals seldom very distinct, but commonly grouped and compressed; scratches glass; does not yield to the knife: sp. gr. 3.50.

*Chemical characters.* In small fragments, it is fusible, with slight effervescence, into a dark coloured enamel. The dark varieties turn yellow before melting. With borax, it turns yellowish, and sinks to the lowest part of the globule, but scarcely dissolves.

*Composition.* Oxide of titanium 35; siliceous 35; lime 30.—*Klaproth.*

*Distinctive characters.* It differs from the red oxide of titanium, in colour, and in crystalline form. The oxide of tin has more of the metallic lustre, and is much heavier than the present species. The brown garnet is much harder, and does not possess its laminated structure.

It occurs chiefly in primitive rocks, and is found in considerable quantities, at various localities. Sometimes it forms a part of the rock in which it is found.

*Localities.* Passau, in Bavaria. Arendal, in Norway, where it is found with magnetic iron, epidote, hornblende, and augite. It also occurs in England, Scotland, France, &c.

U. S. Newton, Sussex county, N. J. in yellowish rhomboidal prisms. Also at Wantage, in the same county. Kingsbridge. On Staten Island. Near Peekskill. At Ticonderoga, and near Lake George, N. Y. Also at Cold Spring, N. Y. where it presents the rhomboidal prismatic form, and from whence magnificent specimens of a dark brown colour, and

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What are the colours of sphene?—What is the composition of sphene?  
—What are the distinctive characters of sphene?



presenting broad flat faces, of several inches in extent, are found. Noble specimens from this locality, are among the collection of Dr. Barrett, of Middletown, who was its discoverer. Petapsco Falls, Md. And also at Bare Hills, near Baltimore. Near the falls of Schuylkill, five miles from Philadelphia. Also at London Grove, in Chester county.

#### GENUS 22. TELLURIUM.\*

When pure, this metal is greyish white, between the colours of zinc, and lead; texture laminated like antimony, which it also resembles, in some of its properties. It melts at a temperature somewhat above 600° Fah.: sp. gr. 6.11; brittle, and easily reduced to powder. Under the blowpipe, it burns with a bluish, or greenish flame, and is volatilized, without the pungent odour, resembling that of horse-radish, by which the native tellurium is distinguished. It is soluble in the acids.

It is found only in the native state, mixed, or alloyed with other metals.

#### *Species 1. NATIVE TELLURIUM.*

*External characters.* Colour, tin white, passing into lead grey; occurs massive, and in minute crystals, which are commonly aggregated, or grouped; primary form unknown, owing to the minuteness of the crystals; secondary forms, the octohedron, variously modified; also occurs in crystalline grains, and plates; lustre, strongly metallic; structure foliated; yields to the knife; brittle: sp. gr. 5.7 to 6.11.

*Chemical characters.* Fusible, and volatile, with a dense white vapour. Emits the smell of horse-radish, only when it is alloyed with selenium.

*Composition.* Tellurium 92.55; iron 7.20; gold 0.25.—*Klaproth.*

*Distinctive characters.* It does not occur like native antimony, in broad foliated plates, neither is it as hard, or as heavy, as antimony. Its colour will distinguish it from native bismuth.

*Localities.* Freebay, in Transylvania, where it is found in a gangue of quartz and porphyry.

U. S. Huntington, in Conn. associated with ferruginous oxide of tungsten, native bismuth, and native silver.—*Silliman.*

\* From the Latin, Tellus, the Earth.

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What is the colour of pure tellurium?—In what state is this metal found?—What are the distinctive characters of native tellurium?

**Variety 1. AURO-ARGENTIFEROUS NATIVE TELLURIUM.**

*External characters.* Colour, steel grey, sometimes approaching tin white; occurs crystallized in the form of four, or six-sided prisms, sometimes variously modified; lustre metallic; structure foliated; crystals very minute; fracture uneven; yields to the knife: sp. gr. 5.7.

The crystals of this variety are arranged so as to resemble written characters, hence the name *graphic tellurium*.

*Chemical characters.* Fusible into a grey globule, with the emission of white vapour, which covers the charcoal, and is an oxide of tellurium. Finally there remains on the charcoal a globule of malleable metal, which is an alloy of gold and silver.

*Composition.* Tellurium 60; gold 30; silver 10.—*Klaproth*.

*Locality.* Offenbanya, in Transylvania, only, where it occurs with native gold, grey copper, and iron pyrites, in porphyry.

This is a valuable ore, and is worked for the gold and silver it contains.

**Genus 23. TUNGSTEN.**

This metal has scarcely been reduced to its pure metallic state. In nature it is found highly oxygenated, and performing the office of an acid, forming the *tungstates* of iron and lime. It is also found in the state of an oxide. According to Joyce its sp. gr. is 17.15.

**Species 1. OXIDE OF TUNGSTEN.—Silliman.**

*External characters.* Colour, various shades of yellow, as orange, or chrome yellow; occurs massive, and pulverulent; fracture of the massive conchoidal, or small foliated; lustre adamantine; brittle: sp. gr. when pure, 6; has neither taste nor smell.

*Chemical characters.* Infusible, and insoluble in acids. Soluble in warm liquid ammonia, from whence it is precipitated white, by acids, but becomes yellow by standing.

*Locality.* It has been found only at Huntington, in Conn. in a gangue of quartz, at Lane's mine. It is associated with the other ores of tungsten, all the known varieties of which are found at the same locality.

This new ore of tungsten was discovered by Benj. Silliman,

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What is the composition of auro-argentiferous native tellurium?—In what state is tungsten found?—What are the colours of the oxide of tungsten?—Where has this ore been found?

L.L. D. of New Haven, and by him first described in his Journal of Science.

*Species 2. TUNGSTATE OF IRON. WOLFRAM.*

*External characters.* Colour, brownish black, or nearly black; occurs massive, and crystallized; primitive form, which it sometimes presents, the rectangular four-sided prism; modifications various; sometimes the crystals are terminated by truncated pyramids; sometimes the prism is so modified as to have ten sides; and sometimes it is in broad six-sided pyramids, terminated by four-sided summits; structure foliated; lustre somewhat metallic; when massive, it presents the aspect of manganese, or masses of iron ore; yields to the knife; opaque; very heavy: sp. gr. 7.15.

*Chemical characters.* Fusible, with difficulty, into a dark scoria; easily soluble in glass of borax.

*Composition.* Tungstic acid 78.77; protoxide of iron 18.32; protoxide of manganese 6.22; siliceous 1.25.—*Berzelius.*

*Distinctive characters.* It resembles oxide of tin, but this, by the continued action of the blowpipe, is reducible to the metallic state. It also resembles the carbonate and oxide of iron, but these are magnetic, or become so when heated.

*Localities.* It occurs in Cornwall, in all the tin mines; also, according to Mohs, in almost every one of the Saxon and Bohemian tin mines, and in Siberia.

U. S. Huntington, Conn. where it is found massive, and in octohedral crystals.—*Silliman.*

*Species 3. CALCAREOUS OXIDE OF TUNGSTEN.*

*External characters.* Colours, white, passing into yellowish grey, and reddish brown; occurs crystallized, and massive; primitive form, the acute octohedron; secondary forms, the octohedron, bounded by isosceles triangles; the cuniform octohedron, and the regular octohedron, variously modified by truncation; structure imperfectly foliated; lustre vitreous, or adamantine; translucent; yields to the knife; brittle: sp. gr. 5 to 6.

*Chemical characters.* Infusible, but decrepitates, and turns white and opaque. By digestion with nitric acid, it forms a yellow powder, which is the peroxide of tungsten. With borax it forms a white transparent glass.

*Composition.* Tungstic acid 80.42; lime 19.40.—*Berzelius.*

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What is the appearance of the tungstate of iron?—What is its composition?—What are the colours, and what the composition of calcareous oxide of tungsten?

*Distinctive characters.* It may be distinguished from the light varieties of the oxide of tin by the yellow powder, which it forms with nitric acid.—The carbonate of lead effervesces with acids, the tungstate of lime does not effervesce. The sulphate of barytes is fusible, and is insoluble in acids.

This ore is found in primitive rocks only, and is associated with the ores of tin, tungstate of iron, hæmatite and arsenic.

*Localities.* Oisans, in France, Cornwall, in England, Bitsberg, in Sweden, &c.

U. S. Huntington, Conn. in a gangue of quartz, with the oxides of tungsten.

(For a particular account of the ores of tungsten, as they occur in Huntington, see Silliman's Journal, vol. 1.)

*Genus 24. PALLADIUM.\**

Colour, greyish white, much resembling that of platina. It is ductile, without much elasticity, lustre metallic; structure fibrous, occurs native and alloying, native platina.

*Species 1. NATIVE PALLADIUM.*

*External characters.* Colour, steel grey, inclining to silver white; occurs in grains, composed of diverging fibres; lustre metallic: sp. gr. 11.8 to 12.14.

*Chemical characters.* Infusible alone, but melts with sulphur, or with arsenic, into a brittle mass. With nitro-muriatic acid, it forms a deep red solution, from which it is precipitated in the metallic state by all the metals, except gold, silver and platina.

*Distinctive characters.* The red solution, which it forms with aqua-regia, will distinguish it from all the metals which it resembles.

*Genus 25.—IRIDIUM.†*

Alloy of Iridium and Osmium.—*Wollaston.*

*External characters.* Colour, greyish white, a little darker than platina; occurs in flattish grains, and according to Mohs, in six-sided prisms, with six-sided pyramids, combined in a parallel position, with isosceles; lustre metallic; brittle; harder than platina; structure foliated: sp. gr. 19.5.

\* From the planet Pallas.

† From *iris*, the rainbow, in allusion to the change of colours it gives while dissolving in acids.

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*What is the colour of palladium?—What are its distinctive characters?*



*Chemical characters.* Fusible with nitre, when it becomes black, but again acquires its original colour if heated on charcoal. Not dissolved by aqua-regia, until after fusion with potash or soda.

*Distinctive characters.* It resembles platina, but platina is malleable and soluble in aqua-regia.

This metal is an alloy of iridium and osmium, and is found with native platina in South America.

Of *Osmium* little is known in its metallic state. Its oxide has been obtained by dissolving platina in nitro-muriatic acid, and distilling the black powder which remains with nitre. It possesses some properties different from those of any other metal.

*Rhodium.* This metal, like those above named, has been but little examined. Its specific gravity is 11. It is infusible alone even by the oxy-hydrogen blowpipe. With arsenic it becomes easily fusible, and after long continued heat, the arsenic is driven off, leaving the rhodium in a striated porous mass. It is soluble in the acids, but not malleable. The solutions do not crystallize, but when mixed with water, or alcohol, give a fine red colour.

#### Genus 26. CADMIUM.

This metal has been obtained from some of the ores of zinc, in which it exists in small quantities. Its colour is tin white, it is malleable and ductile, and bears a fine polish. By the blowpipe, it readily inflames, and passes off in the form of a dense vapour, which, when collected, is found to be a brown oxide of the metal. Sp. gr. of the pure metal 8.6.

This metal was discovered a few years since, by Stromeyer.

#### Genus 27.—SELENIUM.

This metal was first noticed in some iron ore from Fahlun, by Berzelius. When pure it is a deep brown colour, with a metallic lustre. It fuses at 220° Fah. and if slowly cooled assumes a crystalline texture. When warmed, it becomes so soft as to be kneaded by the fingers, and may even be drawn out into threads. It sublimes before the blowpipe, giving out a strong disagreeable odour, resembling that of horse-radish. This odour is a good test of the presence of selenium.

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What is said of iridium and osmium?—What is said of cadmium and selenium.

## CLASS VII.

## COMBUSTIBLE MINERALS.

The Minerals belonging to this Class, combine with oxygen, and undergo combustion, under ordinary circumstances, not requiring, like most of the metals, a high temperature, or the aid of pure oxygen, to effect their combustion. The class includes substances widely differing from each other, in their external characters, and chemical properties. In general, their chief ingredients are sulphur, and carbon.

*Species 1. NATIVE SULPHUR.*

**External characters.** Colours, yellow, passing into orange, greenish, or greyish; occurs in nodular masses, and in crystals; form an acute pyramidal octohedron, with scalene triangular faces, and its varieties; fracture uneven, passing into splintery; translucent, or transparent; lustre shining, resinous; acquires negative electricity, by friction; gives the sulphureous odour, when rubbed: sp. gr. 2; refraction double, through parallel faces.

Fig. 178.



Fig. 178. The pyramidal octohedron, with scalene, triangular faces. This is the primitive form.

Fig. 179.



Fig. 179. The same, with the summits truncated.

Fig. 180.



Fig. 180. The same, with the summits replaced, by four triangular planes, forming a low pyramid.

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What are the principal substances belonging to class vii.?—What are the crystalline forms of native sulphur?

Fig. 181.



Fig. 181. In this form the solid angles are replaced by rhombic planes.

**Chemical characters.** It burns with a bluish flame, giving out sulphureous acid gas, which has the property of bleaching vegetable substances.

It is found in veins, in primitive, and secondary rocks.

**Localities.** Murcia, and Arragon in Spain, where it occurs in splendid crystals, in a deposit of gypsum and marl. Suabia, Hungary, and Peru, in mica-slate, and granite. Gibraltar, in swinestone.

**U. S.** At the coal mines, near Richmond, Vir. Chatham, Conn. of a greenish colour, in masses, intermixed with quartz. Barren hill, Montgomery county, Penn. granular, or pulverulent, with reddish white quartz.—*Sheffer*. In the waters of Clifton springs, Farmington, N. Y.—*Mitchell*. Also near West Point, in the cavities of a ferruginous granite rock.—*Douglass*.

#### *Species 2.* VOLCANIC SULPHUR.

**External characters.** Colour, yellow, or yellowish red; occurs massive, investing, cellular, and in small crystals, of the same form as those of native sulphur. In its other characters it agrees with native sulphur.

It is found in the fissures of lava, in volcanic countries.

**Localities.** Iceland, Italy, Gaudaloupe, Nevis, Solfatara, and more or less in almost every volcanic district.

Volcanic sulphur probably owes its origin to the decomposition of metallic sulphurets, by the heat of burning mountains. It is found lining the fissures of lava, and other volcanic products, being elevated from the depths below, by sublimation.

Perhaps the most remarkable deposit of volcanic sulphur, is that of Solfatara, near Naples, in a kind of sunken plain, surrounded by rocks, which is regarded as the crater of an ancient volcano; and from it, since the age of Pliny, has been obtained a considerable proportion of the sulphur used in Europe.—*Phillips*.

In the plain within the crater of Solfatara, smoke issues

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What is the origin of volcanic sulphur?—What is the chief locality of the sulphur of commerce?

from many parts, as also from its sides ; here, by means of stones and tiles, heaped over the crevices through which the smoke passes, they collect *sal ammoniac* ; and from the sand of the plain they extract *sulphur* and *alum*.—*Hamilton*.

*Species 3. DIAMOND.*

*External characters.* Colourless, or of a yellowish, bluish, yellowish green, clove brown, brownish black, Prussian blue, or rose red colour ; occurs crystallized, and in roundish grains, which often present indications of crystalline faces ; form, the octohedron, with its varieties ; faces often convex ; structure perfectly lamellar, with cleavage parallel to all the planes of an octohedron ; transparent, translucent, or opaque : sp. gr. 3.5. It is the hardest of all known substances. Refraction simple.

*Chemical characters.* At a white heat its combustion is slowly effected. When burned in oxygen gas, the combination forms carbonic acid gas, hence, its composition is pure carbon.

The secondary forms of the diamond are very numerous. The following are among the most common.

Fig. 182.

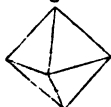


Fig. 182. The primitive form, a regular octohedron.

Fig. 183.



Fig. 183. This figure is intended to exhibit the laminated structure of the diamond, when cleaved.

Fig. 184.



Fig. 184. The octohedron, with the edges replaced by interrupted, narrow, convex surfaces. This is the most common truncated variety.

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What are the colours of the diamond ?—What are the chemical characters of the diamond ?—What are the crystalline forms of the diamond ?



Fig. 185.



Fig. 185. The primitive octohedron, so modified as to present forty-eight curvilinear faces, each face of the primitive, being divided by elevated edges, into six smaller ones.

The mode of searching for diamonds, in Brazil, is described by Mawe. In that country, the diamond mines are the beds of certain rivers which in the summer season become dry. During this season, the gravel, or soil, which has been deposited by the heavy rains, is removed, and placed in heaps on the nearest plain. When the rain commences, and the water becomes abundant, the miners wash this soil in small conical bowls, until all the mud and earthy particles are carried off, and the gravel is entirely clean. It is then carefully searched for the diamonds, and particles of gold, both of which are at or near the bottom of the vessel.

In India the diamond mines extend through a long tract of country, from Bengal to Cape Cormorin. The chief of these are now between Golconda, and Masulipatam, where the diamonds are found in beds of ferruginous sand or gravel. Fifty years ago there were more than twenty places in the kingdom of Golconda, in which diamonds of different sizes were found, and fifty places were also wrought in the kingdom of Visapour. Many of these mines are now abandoned, there being none but small diamonds found in them. At present, the diamonds of Pastael, twenty miles from Golconda, at the foot of the Gate mountains, are most in request.—*Phillips*.

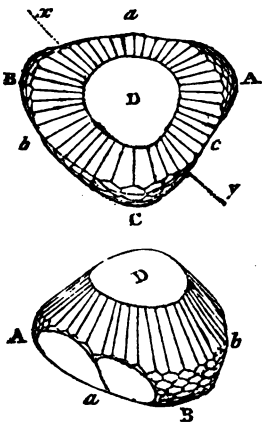
The following list contains all the known diamonds, of remarkable size, existing.

The great diamond brought from India, and for which the India company asked £30,000, was by far the largest in Europe, except the Pitt diamond, belonging to the French crown. Its weight is  $89\frac{1}{2}$  carats, and its worth at £80 the carat, would be £637,000. The following figures represent the size and shape of this diamond.

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Where is the diamond found?—What are the modes of searching for the diamond?

Fig. 186.



The upper figure is a geometrical view of the diamond, from its upper face; the lower figure is a perspective view, taken in the direction of the dotted lines *x*, *y*, of the upper figure. The letters *A*, *B*, *C*, set against the angles of the figure, and *a*, *b*, *c*, against the intermediate sides, respectively refer the same parts of the figure to each other. *D*, both in the geometrical and perspective drawing, marks the upper, or flat face; and the inclined position of the latter, in the perspective view, indicates the direction of the plane.—*Shaw's Nature Displayed*.

One of the largest diamonds, hitherto known, is in the possession of the Rajah of Mattan, in the island of Borneo, where it was found about a century since. It is shaped like an egg, with an indented hollow near the smaller end. It is of the finest water, and weighs 367 carats, or 2 oz. 169 grs. Troy.

For this diamond the governor of Batavia offered the Rajah one hundred and fifty thousand dollars, two large brigs of war, with their guns and ammunition, and a certain number of great guns, and a quantity of ammunition besides. The Rajah, however, refused, partly, perhaps, because the stone was considered to possess miraculous powers, the water in which it was dipped being an imaginary remedy for all diseases. The fortune of his family was also supposed to be connected with this stone.

The Queen of Portugal was said to have possessed a diamond weighing eleven ounces, which, according to the rule of estimating its value, at £80 the carat, would be worth £224,000,000 sterling. This stone is however said to be a white topaz.—*Bingley*.

The Pitt diamond was brought from India, by George Pitt, Esq. and sold by him, to the Regent Duke of Orleans, for about £100,000 sterling. It is the same which was set in the hilt of Napoleon's state sword.

The sceptre of the Emperor of Russia is adorned with a diamond about the size of a pigeon's egg. It had once been the eye of an eastern idol, and is said to have been stolen by a French grenadier, who contrived to become one of the

priests of the idol, for this purpose. Count Orloff bought it for Queen Catharine, for £90,000 sterling, and an annuity of £4000 a year, during the life of the person who sold it.

A diamond in possession of the Great Mogul, is said to weigh about 280 carats, and is valued at £700,000 sterling. This diamond, in the rough, weighed 793 carats.

The King of Portugal possesses a diamond weighing 215 carats.

The following is a part of the inventory of the crown jewels of France, according to the estimate of a commission of jewellers, appointed by the National Assembly, in 1791.

	<i>Weight Estimated at</i>	
	<i>in carats.</i>	<i>Dolls.</i>
1. <i>Le Regent</i> , or the Pitt diamond,	136 14-15	2,220,000
2. <i>Le Sancy</i> , a translucent diamond, cut in facets,	33 11-16	185,000
3. A rich sky blue brilliant,	67 2-16	555,000
4. A pear-shaped diamond, of a peach blossom colour,	24 13-10	37,000
5. The mirror of Portugal,	21 2-16	46,250
6. A brilliant diamond,	26 12-16	32,750
7. A diamond, cut in facets,	28 1-16	46,250
8. A colourless brilliant,	14 14-16	32,750
9. A peach blossom brilliant,	14 12-16	5,550
10. A brownish brilliant,	13 8-16	6,475
11. A yellowish brilliant,	11 2-16	1,850
12. A wine coloured brilliant,	18 9-16	13,875
13. Fifteen brilliants, weighing from 5 to 10 carats each,		154,105
14. 1631 small diamonds, weighing in all,	425	14,287
15. A pale blue brilliant,	31 12-16	55,000
16. An epaulette, containing 9 larger and 197 smaller brilliants,		8,695

The above list will serve to show the immense disproportion there is between the value of small and large diamonds, and also, how their value is increased or diminished, by transparency, and by colour. Thus, number 8 is more than seven times as valuable as number 9, because it is colourless.

*Rule for estimating the value of diamonds.* Diamonds are valued by the *carat*. A carat is 4 grains. The estimate is made by squaring the number of carats, and multiplying the

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What is the method of ascertaining the value of diamonds ?

result by the price of a single carat. Thus the price increases in a much greater proportion than the weight.

The price of a small rough diamond, fit for polishing, is £2 the carat. One weighing 2 carats, is worth,  $2+2=4 \times 2\text{£} = 8\text{£}$ . One of 4 carats,  $4 \times 4 = 16 \times 2 = 32\text{£}$ . One of 10 carats,  $10 \times 10 = 100 \times 2 = 200\text{£}$ .

The value of small diamonds, cut and polished, is from £6, to £8, the carat. One weighing 10 carats, or 40 grains, would therefore be worth,  $10 \times 10 = 100 \times 6 = \text{£}600$ , or \$2,666, 64, at £6 the carat. But some large and beautiful diamonds are valued at £80 the carat.

The first attempt to polish the diamond was made by rubbing two against each other. In this way, after years of incessant labour, a diamond was polished. At the present time, diamonds are cut with copper wire, coated with *diamond bort*, or dust, and polished on a wheel with the same.

When cut and polished, diamonds are divided by jewellers, into *brilliant*, *rose*, and *table* diamonds, depending on the form and number of their artificial faces.

The coloured varieties are seldom cut and polished for jewellery, but are powdered for polishing the transparent variety.

When a diamond is perfectly colourless, and transparent, it is said to be of the *first water*.

Diamonds are set without a back, and when worn as head dresses, &c. are placed on black velvet.

#### *Species 5.* MINERAL CHARCOAL.

*External characters.* Colour, black, or greyish black; consists of charcoal, with various proportions of earth and iron; but without bitumen; lustre glimmering; structure fibrous, with a texture like wood. It is a little heavier than common charcoal.

*Chemical characters.* Before the blowpipe, it is reduced to ashes, without either flame or smoke.

It occurs in thin layers in several formations of mineral coal. Sometimes the two kinds are found attached to each other.

#### *Species 5.* CARBURET OF IRON. BLACK LEAD.

*External characters.* Colour, steel grey, passing into iron black; occurs in amorphous or reniform masses, or disseminated in other minerals; also, according to Phillips, in regular six-sided crystals, with striated summits; lustre glittering,

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How are diamonds polished?—What is the proper name of black lead?

metallic ; fracture uneven, granular, or foliated ; unctuous to the touch ; soils the fingers ; writes on paper or wood ; opaque ; conducts electricity : sp. gr. 2.

*Chemical characters.* Before the blowpipe, slowly consumes, leaving a small portion of oxide of iron on the charcoal. With borax, it dissolves and coats the outside of the globule, metallic black.

*Composition.* Carbon 96 ; iron 4.—*Saussure.*

*Distinctive characters.* It resembles sulphuret of molybdena, but is commonly less brilliant. The two minerals are readily distinguished by the blowpipe, with borax. The graphite slowly dissolves, or separates into small particles, which incrust the surface of the borax. The molybdena adheres to the surface in distinct brilliant scales, not being in the least altered by the heat.

*Localities.* U. S. Cornwall, Conn. in considerable quantities.—*Brace.* Tolland, Sharon, and Hebron, Conn. Two miles from Holland meeting house, Mass. Chester, and Mount Monadnock, N. H. Sutton, do. of a good quality.—*Cleveland.* Transylvania, Buck's county, Vir. in considerable quantity.—*Conrad.* From this graphite, good pencils have been made in New York.—*Cleveland.* Near Lake Champlain, near the city of New York, and near Lake George, N. Y. At the latter locality, it is sometimes found in masses weighing 12 pounds, and is very compact.—*Gibbs.*

*Uses.* The fine kinds of graphite are sawn into thin plates, one edge of which is then inserted into a groove, in a small semi-cylinder of cedar wood, which is then sawn off in a line with the wood, and the other half glued on. In this manner, the common black lead pencils are made. Crayons are made by melting the refuse, or sawings, with sulphur, and then casting it into moulds. These are easily distinguished, when rubbed, or heated, by their sulphureous smell.

Graphite is also used to form crucibles, which are much less liable to fail at high degrees of heat than those made of clay and sand.

#### *Species 6. ANTHRACITE.\**

*External characters.* Colour, greyish black ; occurs massive, slaty, and columnar ; lustre metallic ; often presenting irised, or tarnished, splendid metallic colours, consisting of

\* From the Greek ; consisting of carbon.

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What is the composition of carburet of iron ?—What are the uses of black lead ?—What is anthracite ?



red, blue, and yellow, intermixed; easily frangible; some times soils the fingers; opaque: sp. gr. 1.40 to 1.60.

*Chemical characters.* Before the blowpipe it slowly disappears without flame, smoke, or smell. When burning in a wind furnace, the small quantity of water which it contains, is decomposed, and the hydrogen gives a feeble flame.

*Composition.* From 72 to 95 per cent. of carbon; the residue being oxide of iron, siliceous, and alumine.

*Distinctive characters.* It resembles graphite, but its fracture presents a more shining and conchoidal surface. With borax, it floats on the surface without change, while the graphite slowly dissolves and coats the surface. It is heavier than common mineral coal, which also gives out a bituminous odour before the blowpipe.

*Localities.* Near Allemont, in France, anthracite forms layers in a bed of black slate, at an elevation of about 7,500 feet above the level of the sea. In England, it is found in the coal formations of Walsal, in Staffordshire. In Scotland, at Carlton Hill, near Edinburgh, and in several other places. In Wales, there are several formations of anthracite. It also occurs in Holland, Norway, Switzerland, Savoy, Spain, &c.

In England, it is called *stone coal*, in Scotland, *blind coal*, and in Ireland, *Kilkenny coal*.

*U. S.* The anthracite formation of Pennsylvania, is very extensive. From the northeast branch of the Susquehannah, it extends eastward about 30 miles, and westward from the same river, about 2 or 3 miles. It extends down the Susquehannah, to about 10 miles below Sunbury. The waters of the rivers Fishing, Lehigh, Muncey, and Schuylkill, pass through this formation. On the Schuylkill, it extends to about 20 miles above reading. At Wilkesbarre, the anthracite appears at the surface, and there forms a bed from 20 to 30 feet thick. Mines are worked at Wilkesbarre, and at the heads of the Lehigh, and Schuylkill rivers. "At Wilkesbarre, the price is 12½ cents the bushel. At Philadelphia it has been sold at 50 or 60 cents the bushel; but by improvement in the navigation of the rivers, its price must be lowered to 25 or 30 cents.—Cooper.

This anthracite is of a jet black colour, sometimes inclining to lead grey; lustre shining, sometimes splendid, and semi-metallic; not very brittle; does not soil the hands: sp. gr. about 1.60.

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*What is the composition of anthracite?—What are the chief localities of anthracite in this country?*

In Portsmouth, Rhode Island, reposes a bed of anthracite, which has been worked, more or less, for many years. Its colour varies from lead grey, to greyish black; structure slaty; sometimes breaks into small rhomboidal fragments, the general surface of the fractured faces being uneven, or hackly. It soils the fingers, and is easily broken. Its specific gravity, according to Dr. Meade, is from 1.45 to 1.75; and its composition about 94 per cent. of carbon, without any contamination from sulphur. The remainder appears to be chiefly iron, and silex.

According to the experiments of Mr. Marcus Bull, of Philadelphia, the comparative value of the Rhode Island, and Lehigh anthracites, for fuel, is as 71 to 99.

*Species 7. MINERAL OIL.*

There are two varieties of this species, viz. *naptha*, and *petroleum*.

*Variety 1. NAPTHA.*

*External characters.* Colour, yellowish, or wine yellow; sometimes without colour, and transparent; it exhales a strong bituminous odour, and burns with a blue flame, and much smoke, leaving no residuum. It swims on water: sp. gr. from 0.71 to 0.85, water being about 100.

It is exceedingly inflammable, and takes fire even on the approach of flame.

*Composition.* Carbon 87.21; hydrogen 12.79.—*Saussure.*

When distilled and made perfectly pure, it contains neither water, nor oxygen, in any other form.

Pliny and Galen suppose, that this was the substance with which Medea destroyed Creusa, the daughter of Creon. She sent that unfortunate princess a robe, besmeared with a substance which burst into flames, as soon as she approached the altar where incense was burning, and thus was miserably destroyed.

Beckmann has related several instances where effects, considered magical, were produced by the extreme inflammability of this substance.

*Localities.* Copious springs of *naptha*, occur on the Caspian sea. The earth in that vicinity constantly exhales its vapour, and it is said that the inhabitants, by concentrating this vapour, and passing it through tubes, have perpetual lights, and that they cook their food by this kind of fire. It is col-

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*How is mineral oil obtained?—What is said of the inflammability of mineral oil?*

ected by digging wells a few yards deep. It is also found in Sicily, Dalmatia, Hungary, Siberia, &c. The streets of Genoa, are said to be lighted with it, instead of oil.—*Phillips*.

*Variety 2. PETROLEUM.*

*External characters.* This is a black, bituminous, semi-fluid, with a strong odour, especially when heated. It is very combustible, and burns with a copious, thick and black smoke, leaving a small quantity of coaly residue. By distillation, it yields a colourless fluid, which resembles naphtha in many of its properties, and probably does not differ materially from that substance.

It is found in many countries, particularly in the vicinity of coal formations.

*Localities.* France, at several places. England. St. Catharine's Well, at Edinburgh. Bavaria. Switzerland. Near Parma, in Italy.

But it is most plentifully found in Asia. In the Birman empire, in one neighbourhood, there are 520 wells in full activity, into which petroleum flows from over coal formations. The quantity of petroleum annually produced by them, amounts to more than 400,000 hogsheads. In that section of country, it is used instead of oil for lamps. Mixed with earth, or ashes, it is used for fuel.—*Phillips*.

It is said that when naphtha is exposed to the air, it becomes brown, thickens, and passes into petroleum. It has already been observed, that petroleum when distilled, yields a fluid much resembling naphtha. It is most probable, therefore, that naphtha becomes petroleum, after the loss of its more pure and volatile particles.

U. S. Robertson enumerates 11 localities of petroleum in the United States. Only the most important can be mentioned.

Five miles from Scottsville, in Ken. It is found on a spring of water, and sells at 25 cents the gallon.—*Jessup*. Seneca Lake, N. Y. It is called *Seneca oil*, and is collected in considerable quantities.—*Cleveland*. Medina county, Ohio, and in several other places in that state.

*Species 9. MINERAL COAL.*

*External characters.* Colour, black, or brownish black; occurs massive, and slaty; lustre shining, often with an iridescent tarnish, and pseudo-metallic lustre, which is some-

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What is petroleum ?



times very beautiful; fracture large conchoidal, or uneven; yields to the knife, but not to the nail; easily broken; opaque: sp. gr. about 1.30.

*Chemical characters.* Most varieties of coal burn easily, and with more or less flame. When submitted to distillation, they yield carburetted hydrogen, a bituminous oil, a quantity of mineral tar, and a portion of ammonia.

*Composition.* From 97 to 40 per cent. of carbon; from 47 to 9 per cent. of volatile matter, and from 3 to 13 per cent. of ashes.

There are several varieties of this species, depending chiefly on colour and purity.

*Variety 1. BLACK COAL.*

*External characters.* Colour, black, often with an iridescent tarnish; occurs massive; fracture in one, and sometimes in two directions; slaty; fragments, after cleavage, rhombic, or cubic; cross fracture, imperfectly conchoidal, or uneven; sometimes contains layers of mineral carbon: sp. gr. 1.45.

*Chemical characters.* Burns with a bright flame, and much smoke, but does not swell and agglutinate.

*Composition.* Carbon 75.28; hydrogen 4.18; azote 15.96; oxygen 4.58.—*Thomson.*

This is the most abundant and common of all the varieties of coal, and is the principal fuel of many countries, particularly of England.

*Variety 2. CANNEL\* COAL.*

*External characters.* Colour, black; texture compact; fracture large conchoidal; lustre glistening, and resinous; hard, and brittle; bears a fine polish: sp. gr. 1.23 to 1.27.

*Composition.* Carbon 75.2; bitumen 21.68; ashes 3.12.—*Kirwan.*

It decrepitates when first heated, and burns without softening, with a bright flame, and rather pleasant odour.

It is sometimes worked into ink-stands, snuff-boxes, toys, &c.

*Localities.* Wigan, and Whitehaven, Eng. Gilmerton, and other places, in Scotland.

Coal is found chiefly among secondary rocks, where it occurs in beds of various extent and thickness.

\* *Cannel*, is a corruption of *candle*. It is sometimes used to give light, instead of candles.

What is the most abundant of all the varieties of mineral coal?

In many instances, these beds lie one over another, with earth interposed between them. At Whitehaven, in England, 20 distinct beds have been explored, lying one above the other. Near Liege, there are 60 beds, occurring in the same manner.

It is a general observation, that the layers of slate, which form the roofs of coal beds, bear impressions of vegetables, and particularly of ferns.

Coal is sometimes found in highly elevated situations. According to Brongniart, it occurs on the Cordilleras, in South America, at the height of more than 13,000 feet above the level of the sea.

The deepest coal mines are said to be those of Namar, one of which is 2,400 feet deep.—*Pinkerton*.

Coal mines are subject to spontaneous combustion, probably in consequence of the decomposition of the pyrites, which some coal beds contain in abundance. Some mines are known to have been on fire for years, and then to have ceased burning.

Heaps of coal, when large, and exposed to a small quantity of moisture, are subject to the same accident.

The coal mine at Whitehaven, England, is 1200 feet deep, and extends more than 5000 feet under the sea.

The United States contain many coal formations, which have been explored, more or less extensively.

In Virginia, at least 25 shafts have been sunk for the raising of coal, within an extent of 70 miles. At Heth's mine, according to Grammer, the bed of coal is 50 feet thick, and one of the shafts is 350 feet deep. The strata which cover the coal are sandstone, and argillaceous slate, often exhibiting vegetable impressions. Pure charcoal, says the same writer, in the form of sticks or logs, is frequently associated with the coal.

In Ohio, coal is found in different parts of the state. In some cases, three successive beds are found, separated from each other, by argillaceous slate, bearing vegetable impressions. The bed nearest the surface, according to Atwater, burns well, agglutinates, and leaves only a small residuum; that of the second bed, is coarse, burns with a flame less bright, and leaves a greater residuum; while that of the third bed, though much more abundant, is inferior in quality.

In Pennsylvania, the country watered by the western branch

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What is the origin of mineral coal?

of the Susquehannah, is chiefly a coal formation. Indeed, coal, in greater or less quantities, is supposed to underlay about one third of that state. At Pittsburg, where it is found on, or near the surface, it is pretty extensively explored, as an article of fuel.

In Connecticut, a coal formation commencing at New Haven, crosses Connecticut river at Middletown, and embracing a width of several miles on each side of the river, extends to some distance above Northampton, in Massachusetts.—*Siliman*.

Within the above described tract of country, coal has been found at Durham, Middletown, Chatham, Hartford, Farmington, Windsor, Enfield, and South Hadley. The quantities found, have been small, and have occurred, sometimes in veins, between strata of clayslate, and sometimes in detached pieces. That of Windsor is a vein in clay slate, and is about an inch thick at the surface. A small quantity found in Farmington, is very full of bitumen, and burns with a bright blaze, and black smoke.

*Origin of Coal.*—All naturalists, says Jameson, are now agreed, that the greater part of coal is derived from vegetables, which have been altered by certain natural operations, hitherto but imperfectly known.

It often happens, that charcoal is found with perfect mineral coal. In some instances, one side of a specimen will be mineral coal, and the other side, charcoal. In several coal mines, the remains of trees, either petrified, or partly penetrated with bituminous matter, have been discovered. Indeed, most of the phenomena observed, on a close examination of this subject, indicate the vegetable origin of coal.

#### *Species 10. LIGNITE.*

*External characters.* Colour, brown, or brownish black; occurs massive; structure woody; burns with a weak flame, and the odour of peat. The compact varieties are black, with a resinous lustre, and imperfectly conchoidal, or uneven fracture. The less compact kinds are brown, and without lustre.

*Chemical characters.* It burns with flame, but does not swell and agglutinate like coal. The odour is not bituminous, but like that of decayed vegetation, and similar to that of peat.

*Composition.* Carbon 45; water 30; oily bitumen 10; gases 15. There is, however, much difference in the composition of the several varieties.

The external characters of lignite, together with its chemical properties, evince that it is of vegetable origin. Indeed, the branches of trees, but little changed, are sometimes found among it.

*Variety 1. FIBROUS LIGNITE. BITUMINOUS WOOD.*

*External characters.* Colour, brown, or clove brown; texture and form, that of wood; longitudinal fracture, fibrous; cross fracture, uneven, displaying the annual circles of the tree; opaque; brittle, friable, and light.

It is easier to break, than wood; under the knife, it assumes a kind of lustre.—*Brongniart*.

*Localities.* Bovey, in England. Iceland. Munden, in Hanover. Near Paris. Abundant\* in the amber mines of Prussia.

At Bovey, Brongniart says, there are 17 thick beds of lignite, which are at the depth of about 66 feet.

It is very abundant in Iceland. In many instances, the trunks of the trees are perfect, being merely compressed into an oval shape. This variety passes by imperceptible degrees, into those which are more distinctly carbonaceous. In many instances, the several varieties are found together, and sometimes the same specimen will show the brittle and fibrous varieties.

The coal, says Shaw, in the centre of the lowest bed, is of a black colour, nearly as heavy as pit coal, makes a strong and durable fire, and is in all respects a perfect mineral coal. The other beds are more of a chocolate colour, not so heavy, and with more of the appearance of wood, consisting of pieces which lie crossing each other in all directions. Some pieces are found, which have the knots of wood in them, in one part, while another portion of the same piece, is converted into perfect mineral coal. So that nature in this instance, is seen in the very act of forming mineral coal, from vegetable matter.—*Shaw's Nature Displayed*, Vol. ii.

*Variety 2. EARTHY LIGNITE.*

*External characters.* Colour, black, or brownish black; occurs massive; fracture and aspect, earthy; texture fine grained; smooth to the touch; somewhat friable; when burned, emits a disagreeable odour. It is nearly as light as water.

*Localities.* Near Cologne; Hessa; Bohemia, Saxon Iceland, &c.

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*What is the origin of lignite?*



It forms very extensive beds in the environs of Cologne, where it is covered with a bed of pebbles, of quartz, and jasper, and embraces trunks of trees, of a black, or reddish colour, and compressed into an oval shape.—*Cleaveland*.

This lignite is used as fuel; also for painting in distemper, and oil. The Dutch use it to adulterate their snuff, which is said to give it a much esteemed fineness, and softness.

Faujus observes, that the trunks of trees, which are found in beds of lignite, are always deprived of their branches, hence he concludes that they have been conveyed by the ocean.

The same author relates, that nuts which now belong only to Hindostan, and China, together with a kind of frankincense, are found in the bed at Cologne.—*See Pinkerton's Petrology*.

Authors agree that lignite is an entirely different formation from that of coal, and that it is in fact, a deposit of wood, which has been covered by earth, and in consequence, undergone a change by which it only approximates to coal. It is, however, most probable, that in time, it will be completely mineralized and converted into coal.

#### *Species 11. JET.*

*External characters.* Colour, jet, or pitch black; occurs in masses, or thin layers; texture compact; fracture conchoidal, and undulated; lustre shining; perfectly opaque; sometimes the texture is ligneous, and the specimen is in the form of the branch of a tree. It becomes weakly electric by friction: sp. gr. 1.25.

*Chemical characters.* It burns with a greenish flame, and emits a strong bituminous smell.

It is found with coal of the newest formation, and sometimes with lignite and amber.

*Localities.* Various places in England; Aude, in France. Various places in Germany. Silesia, Hessa, Italy, Spain, and Prussia.

Brongniart says, that jet, proper to be worked, is found in masses, the weight of which seldom exceeds 50 pounds.

*Uses.* It bears a fine polish, and is worked into trinkets, and mourning ornaments. In France, in the Department of Aude, 1200 persons are employed in fabricating the jet, which is found there, into rosaries, buttons, ear-rings, snuff-boxes, bracelets, &c.—*Journal des Mines*.

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*What use do the Dutch make of lignite?*

*Species 13. AMBER.*

*External characters.* Colours, wine yellow, greenish, or yellowish white, or reddish brown; occurs in nodules, or roundish masses, of various sizes, from grains, to that of a man's head; texture compact; transparent, or translucent; fracture perfectly conchoidal; lustre resinous; becomes strongly electric by friction; bears a high polish.

*Chemical characters.* It burns silently, and with little smoke. While burning, it emits a bituminous odour, which is not unpleasant. Soluble in oils, when gently heated.

*Distinctive characters.* It resembles copal, but this, while burning, crackles, and emits an aromatic resinous odour; while amber burns silently, and emits an odour distinctly bituminous.

*Localities.* Greenland; Moravia; Poland; France; Prussia.

It is found among sand and gravel, accompanied with lignite, bitumine and jet.

In Prussia, a mine of amber is explored to the depth of more than 100 feet. Under a stratum of sand and clay 20 feet thick, there succeeds a stratum of trees 40 or 50 feet thick. The wood is partly decomposed, and impregnated with pyrites and bitumen, and is of a blackish brown colour. Under the stratum of trees, and sometimes attached to them, the amber is found; it is most probable, therefore, that it has proceeded from the vegetable juices.—*Phillips*.

The amber pits of Prussia are said to afford the king a revenue of \$26,000 dollars annually.—*Parkes*.

U. S. At Cape Sable, in Ann-Arundel county, Md. It occurs in a bed of lignite, and is found in grains, or masses, sometimes 4 or 5 inches in diameter.—*Troost*. *Cleveland*. Near Trenton, N. J., and Camden, opposite to Philadelphia. At the latter place, a transparent specimen was found, several inches in diameter.—*Woodbridge*. That found near Trenton, occurs in small grains, and rests on lignite, or carbonated wood, or even penetrates it.

*Uses.* It is cut into articles of ornament and dress, as ear rings; bracelets, beads, amulets, &c. It bears a high polish, and was anciently considered the most precious of jewels. The greatest quantity at present is purchased by the Armenian, and Grecian merchants.—*Jameson*.

It often contains insects of various species, in a state of complete preservation. These are sometimes introduced by art, in order to increase the value of the specimen.

There is no doubt but *gum copal* is often sold for amber, as, when cut and polished, the pale varieties of amber cannot easily be distinguished from copal. By attending attentively to the distinctive characters above pointed out, the two substances may readily be distinguished.

## EXPLANATION OF TERMS, &c.

### COMMONLY USED IN MINERALOGICAL DESCRIPTIONS.

- Acuminated.** Having the point drawn out.
- Acicular.** Long, slender, and straight prisms, or crystals, are termed acicular, from the Latin, *acicula*, a little needle.
- Aggregated.** A mineral rock is said to be aggregated, when the several component parts only adhere together, and may be separated by mechanical means: the felspar, quartz, and mica, constituting granite, may be separated mechanically. Granite is an aggregated rock.
- Alloy.** A natural combination of two or more metals in the metallic state.
- Amalgam.** A natural combination of two metals, of which mercury is one.
- Amorphous.** Without form; of undefinable shape; from the Greek, (*amorphous*), having that signification. Amorphous minerals are sometimes described as being of indeterminate, or indefinite forms.
- Anhydrous.** from the Greek, (*anudros*), signifying without water; anhydrous gypsum is without water.
- Arborescent.** From the Latin, *arboresco*, to grow like a tree; see Dendritic.
- Arsenate.** A term applied to a mineral consisting of the *arsenic acid* united with a base, as of copper in the arseniate of copper.
- Base.** A term denoting the substance to which an acid is united; in the arseniate of copper, the copper is the base.
- Borate.** A mineral in which the boracic acid is combined with a base, as of magnesia, in the borate of magnesia.
- Botryoidal.** From the Greek, (*botruodes*), signifying hung with clusters of grapes or berries. So a mineral presenting an aggregation of large sections of numerous small globes, is termed botryoidal; but when the globes are larger, and the portions are less, and separate, the appearance is expressed by the term *mamillated*. These forms may be observed in certain ores of cobalt, copper, and manganese, and often in *chalcedony*.
- Bladed.** This term relates chiefly to the structure of such minerals as, on being broken, present long flat portions longitudinally aggregated, and somewhat resembling the blade of a knife; this appearance may in general be considered as the effect of interrupted crystallization.
- Brittle.** This character of mineral bodies does not depend upon their hardness; those of which the particles cohere in the highest degree, and are immovable one among another, are the most brittle. The diamond, quartz, sulphate of barytes and sulphur, vary greatly as to hardness; they are all brittle, the first only in particular directions.
- Canaliculated;** presenting deep channels on the surface, resulting either from interrupted crystallization, or the aggregation of numerous crystals.
- Capillary,** is derived from the Latin, *capillus*, a hair, and is chiefly used to express the long, tortuous, hair-like appearances, to be observed in native gold, and silver, and some other minerals. Crystals are sometimes termed capillary, when long and slender; but when straight, they are more properly designated by the term *acicular*.
- Carbonate.** A mineral in which the carbonic acid is combined with a base, as of lime, in the carbonate of lime.
- Cavernous.** A mineral in which there are considerable hollows or cavities, is said to be cavernous.
- Cellular.** This term was used by Werner, in the description of such minerals as exhibit cells formed by the crossing and intersecting of the laminae or



- lamellæ of which they are constituted: commonly, any mineral presenting numerous small cells or cavities, is termed cellular: see vesicular.
- Chatoyant*, has been adopted from the French, who use it to express the changeable light resembling that to be observed in the eye of a cat, to be seen in certain minerals; as in the cat's-eye.
- Chromate*. A mineral in which the chromic acid is united with a base, as of lead, in the chromate of lead.
- Cleavage*. This term is most commonly used in relation to the fracture of those minerals which, having natural joints, possess a regular structure, and may be cleaved into more or less geometrical fragments; as into varieties of the parallelopiped, the rhomboid, &c.
- Coherent*. In minerals that are brittle, the particles are strongly coherent; in such as are friable, they are slightly coherent.
- Combustion*. During the burning of a combustible, in common cases, oxygen unites with it, or with some of its ingredients: and the product of the combustion is either an oxide, an acid, or an alkali.
- Compact*. A mineral is compact when no particular or distinct parts are discernible; a compact mineral cannot be cleaved or divided into regular or parallel portions. The term compact is too often confounded with the term massive.
- Concentric lamellar*. This may be said to relate to structure, being used in the description of such minerals, as, being of a spherical form, or of any portion of a sphere, have received successive coatings of depositions. If an onion be cut in two, it exhibits the concentric lamellar in perfection.
- Conchoidal*, relates only to fracture; and is doubtless derived from the Latin, conchoides, signifying like the shell of a fish. Fragments of many of the brittle minerals exhibit this appearance, and occasionally in great perfection, as quartz, and sulphur: the fracture of compact minerals is frequently more or less perfectly conchoidal.
- Concretion*, generally signifies a small and distinct mass.
- Coralloidal*, resembling branches of coral.
- Cuneiform*, wedge-shaped; cuneus, in Latin, signifies a wedge.
- Cuneiform octohedron*. See octohedron.
- Decomposed*. This term when used strictly in a mineralogical sense, imports the consequence of the chemical action which takes place naturally in some minerals. Certain ores of iron, &c. in which sulphur predominates in an unusual degree, decompose by exposure to air.
- Decrepitate*. A mineral is said to decrepitate on exposure to heat, when it flies with a crackling noise similar to that made by salt when thrown into the fire.
- Dentritic*; derived from the Greek, (dentritis,) signifying like the growth of a tree. The terms arborescent and dentritic are used synonymously: they are alike applied to the tree-like appearance in which native silver and native copper are sometimes found; to the delineations seen on the surfaces of certain minerals; and to the appearance in the mocha-stone, &c.
- Dentiform, or dentated*; in the shape of teeth; dens being the Latin, for a tooth.
- Disseminated*. When a mineral, whether crystallized, or otherwise, is found here and there imbedded in a mass of another substance, it is said to be disseminated in the mass. Crystals of quartz sometimes occur, disseminated in Carrara marble, &c.
- Disintegrated*. This term is generally used to express the falling to pieces of any mineral, without any perceptible chemical action.
- Diverging, or divergent*. When the structure is fibrous, and the fibres are not parallel, they usually diverge in part, but not wholly, around a common centre; as in certain zeolites, and hæmatitic iron ores. The crystals of some substances assume a diverging position.
- Drusy*, has been adopted from the German term drusen, for which we have no English word. The surface of a mineral is said to be drusy when composed of very small prominent crystals nearly equal to each other; it is often seen in iron pyrites.

**Efflorescence.** An efflorescence is the consequence of chemical action ; it is usually applied to such minerals as are found in extremely minute fibres on old walls, &c. &c.

**Elastic.** A mineral which after being bent, springs back to its original form, is elastic. Mica is elastic ; talc, which greatly resembles mica, is only flexible, not elastic.

**Earthy.** This term relates to fracture, and to texture. Chalk and certain of the ores of iron and lead are notable instances of the earthy fracture or texture.

**Fasciculated.** When a number of minute fibres or acicular crystals occur in small aggregations or bundles, they are said to be fasciculated ; a term doubtless derived from the Latin, *fasciculus*, a little bundle. This appearance often occurs in green carbonate, and arseniate of copper.

**Fibrous.** This term relates both to form and structure. Certain minerals, as amianthus, amianthiform arseniate of copper, a variety of gypsum, &c. occur in distinct fibres. Asbestos, gypsum, red hæmatitic iron ore, &c. are found massive, and of a parallel fibrous structure ; some varieties of red hæmatite, and other minerals, are of a radiating fibrous structure, when the fibres diverge from a common centre.

**Filament.** A mineral is said to occur in filaments, when it is found in slender, thread-like, or hair-like portions. It is therefore nearly synonymous with the term capillary.

**Filiform.** is used in the same sense as the preceding ; but Werner confines its use to express the appearance of certain metals which occur in the form of wire, as native silver and native copper. *Filum*, in Latin, signifies thread ; *filum metalli*, wire.

**Flexible.** Talc is flexible ; it readily bends, but does not return to its original form. Mica is both flexible and elastic.

**Fluate.** This term designates a mineral in which the fluoric acid is combined with a base, as with lime, in the fluato of lime.

**Foliated.** This term, which doubtless is derived from the Latin, *foliatus*, having, or consisting of leaves, is used by Werner to express the structure of all minerals that may be divided or cleaved regularly, and are therefore by him said to consist of *folia* or leaves. The structure of such minerals is more commonly and better expressed by the term lamellar ; and they are said to consist of laminae.

**Fracture,** is a term now chiefly employed in designating the appearance of minerals which have no regular structure, when they are broken ; such minerals present an earthy, even, uneven, or a conchoidal fracture, &c.

**Frangible.** The term frangibility has relation to the susceptibility of minerals to separate into fragments by force : this quality in minerals is not dependent on their hardness ; the structure of some, and the brittleness of others, renders them easily frangible ; while others, which from their softness, and the ease with which their particles or molecules yield, or slide over one another, are with much more difficulty frangible ; such minerals possess the character of toughness. Quartz is easily broken ; asbestos is tough.

**Friable.** A mineral whose portions or particles slightly cohere, and which is therefore easily crumbled or broken down, is said to be friable, or in a friable state.

**Fungiform.** Certain substances, as for instance calcareous stalactites, are occasionally met with, having a termination similar to the head of a fungus : whence they are said to be fungiform.

**Gangue, Gangart.** We have these terms from the Germans ; the gangue of a mineral, is the substance, in, or upon which, a mineral is found : it is sometimes termed the matrix. Silver, occurring in, or upon carbonate of lime, is said to have carbonate of lime for its gangue or matrix.

**Geode.** This also we derive from the Germans. A geode is a hollow ball ; at Oberstein, in Saxony, are found hollow balls of agate lined with crystals of quartz or amethyst, which are termed geodes.

*Glance* is also a German word, meaning shining; thus, the followers of that school use the terms glance-coal, copper-glance, &c.

*Globular distinct concretion* is used to designate the form of any mineral which occurs in little round or roundish masses; the pea-stone, and roe-stone are examples of it.

*Granite*. A mineral composed of quartz, mica, and felspar.

*Granular*. The structure of a mineral is said to be granular, when it appears to consist of small grains or concretions, which sometimes can, sometimes cannot, be discerned without the help of a glass; we have therefore the fine granular, and the coarse granular structure.

*Greasy* is used in relation to lustre; fat quartz has a greasy lustre.

*Hockly*. This term relates to a fracture which is peculiar to the malleable metals; which, when fractured, present sharp protruding points.

*Hæmatite* is derived from a Greek word, signifying blood-red; it was first applied by mineralogists to the variety of iron ore which now is called the red hæmatite; but has since been extended to other iron ores of the same structure, but differing in colour. We have also brown hæmatites, and black hæmatites.

*Hepatic*. A term derived from the Latin, hepar, the liver; it is applied either to colour or form. We have hepatic pyrites, hepatic quicksilver; hepatic, &c.

*Hydrate* is derived from the Greek, (udor,) water; and is applied to certain of those minerals (as the hydrate of magnesia) of which water forms an ingredient in very large proportion.

*Imbedded*. A mineral found in a mass of another substance, is said to be imbedded in it. Crystallized quartz occurs imbedded in Carrara marble. It also occurs partly imbedded in other substances, as in fluor.

*Interlacing*. *Interlaced*. When fibres or crystals of a mineral are found intermingling with each other in various directions, they are said to be interlacing, or interlaced.

*Investing*. A mineral coating, or covering another, is sometimes described as investing it.

*Iridescent*. This term relates only to the colour with which the surfaces of some minerals are naturally tarnished; as yellow copper ore, iron pyrites, galena, sulphuret of antimony, &c.

*Irised*. A mineral is described as irised which exhibits the prismatic colours either externally, or internally: the latter is generally the consequence of some injury sustained by the mineral.

*Lamellæ*. If a mineral be found in very minute, thin plates, it is said to occur in lamellæ.

*Lamellar*. This term relates to structure. When a mineral can be fractured, or cleaved into regular and parallel plates, its structure is said to be lamellar; and the portions thus obtained are termed laminæ, or lamellæ: these terms have been adopted from the Latin, in which they were almost synonymously used to express thin plates of any substance.

*Lamellar distinct concretions*. This term is sometimes used to express the form of certain minerals (as the oxide of uranium) consisting of separate tabular crystals.

*Lamelliform*. A mineral consisting of lamellæ, is said to be lamelliform.

*Lenticular* is employed to express the form of certain crystals which are nearly flat, and convex above and beneath; and which consequently resemble a common lens.

*Malleability*. Some of the metals suffer extension when beaten with a hammer; and are therefore termed malleable metals. Native gold and native silver are very malleable metals.

*Massive*. This term is sometimes used in describing a substance of indeterminate form, whatever may be its internal structure; but is more commonly applied to those minerals which possess regular internal structure, without any particular external form.

**Molybdate.** A mineral in which the molybdic acid is combined with a base, as with oxide of lead, in the molybdate of lead.

**Muriate.** A mineral in which the muriatic acid is combined with a base, as with soda, in the muriate of soda.

**Natural joints.** Such minerals as can be broken into regular forms, as the cube, rhomboid, &c. can be cleaved into those forms, only in the direction of, or along their natural joints. In some minerals, however, the natural joints are perceptible by the assistance of a strong light.

**Nacreous,** relates to lustre; and is employed to express the lustre of some minerals (as of pearl spar) which greatly resembles that of pearl. *Nacre de Perle*, in French, signifies Mother of Pearl.

**Nitrate.** A mineral in which the nitric acid is combined with a base, as with potash, in the nitrate of potash.

**Nodular.** A mineral which presents irregularly globular elevations, is termed Nodular. Flint is found in nodular masses.

**Nitro-muriatic acid.** A mixture of muriatic and nitric acid.

**Oblique prism,** see Prism.

**Obtuse octohedron,** see Octohedron.

**Obtuse rhomboid,** see Rhomboid.

**Octohedron.** Octohedrons are of several kinds. An octohedron is sometimes described as two four-sided pyramids, *base to base*. In the regular octohedron, the three sides of each plane are of the same length. In the *obtuse* octohedron, the base is longer than the two sides. In the *acute* octohedron, the base is shorter than the two sides. In some obtuse and acute octohedrons, the base is square, in others rectangular, but not square. In the *rhomboidal* octohedron, the common base is a rhomb or rhombic; and the three sides of each plane are of different lengths. In the *cuneiform* octohedron, the common base of the pyramids is not square, and the planes are not all equal, but resemble each other, two and two, on opposite sides of the pyramid.

**Opake.** Those minerals are opake which do not transmit a perceptible ray of light even through the thinnest and smallest pieces.

**Oxide.** This term is used mineralogically to designate metallic minerals, in which the metal is combined with any proportion of oxygen, which is less than suffices to convert it into an acid. Iron is found in different states of oxidation. Every metal which is found united with an acid, is, when so combined, in the state of an oxide; but when united with sulphur, the metals are not in the state of oxides, but in the metallic state.

**Pass into.** One mineral is said to pass into another, when both are found so blended in the same specimen, that it is impossible to decide where the one terminates, and the other begins. Flint is found passing into chalcodony.

**Pectinated.** If a mineral exhibit short filaments, crystals, or branches which are nearly parallel and equidistant, it is pectinated; pecten, in Latin, signifies a comb.

**Peroxide,** when a metal has the largest quantity of oxygen.

**Porous.** A mineral is said to be porous, when it is traversed in different directions with communicating holes which pass through the substance.

**Prot oxide,** when a metal has the smallest quantity of oxygen.

**Phosphate.** A mineral in which the phosphoric acid is combined with a base, as with lime, in the phosphate of lime.

**Prism.** Prisms have four or more sides surrounding the *axis*: they are sometimes terminated by a *single plane*, and when this plane is at right angles to the axis, we have a *right prism*; but if the terminating plane be at right angles to the axis, we have an *oblique prism*. If the sides of a regular prism are at right angles with each other, we have a *rect prism*, and if the sides be of equal width, a *square prism*, and its base either greater or less than that of the cube.



*Pulverulent.* When the particles of a mineral are very minute and cohere very slightly, or not at all, it is said to be pulverulent; or in the pulverulent state.

*Radiated.* *radiatus*, in Latin, signifies beset with rays; when the crystals of a mineral are so disposed as to diverge from a centre, they are said to be radiated.

*Ramose.* *ramus*, in Latin, signifies the branch of a tree; a mineral having that appearance is described as being ramose.

*Rectangular prism*, see Prism.

*Refractory.* The term is used both chemically and mechanically in relation to minerals. It is sometimes applied to those which strongly resist the application of heat; and occasionally to some whose toughness enables them to resist repeated blows.

*Reniform.* Kidney-shaped; *ren*, in Latin, signifies kidney.

*Retiform, Reticulated.* Minerals occurring in parallel fibres, crossed at right angles by other fibres which also are parallel, exhibit squares like the meshes of a net. *Retis*, in Latin, signifies a net. We have reticulated native silver, native copper, red oxide of copper, &c. And it may be remarked that such minerals as occur reticulated, generally assume the cube, as one of their crystalline forms.

*Rhomboid.* Rhomboids are of two kinds; obtuse and acute. In each there are two points that may be termed the apices. The planes of the obtuse rhomboid, meet at each apex under one obtuse and two acute angles; while the planes of the acute rhomboid meet at the apex under acute angles.

*Schistose structure.* Minerals which split only in one direction, and present fragments which are parallel, but of unequal thickness, which also are not smooth and even, and are without lustre, are said to possess a schistose structure. *Schist*, in the German, signifies slate.

*Secondary crystals, or forms.* Such crystals as do not exhibit any portion of the primary planes, are termed secondary crystals. Thus, in fluor, the cube is a secondary crystal.

*Sectile.* The term sectile is derived from the Latin, *seco*, to cut. Those minerals are termed sectile which are midway between the brittle and the malleable. A slice or portion cut from a sectile mineral, is fragile, and the new surface on the mass is smooth and shining. Plumbago and the soap-stone are both sectile.

*Semi-transparent.* A mineral is said to be semi-transparent when an object is not distinctly seen through it.

*Slaty structure.* This term is synonymous with schistose structure, which see.

*Specular Minerals* are those which present a smooth and brilliant surface which reflects light; those which present only one such surface, which is not crystalline, are commonly termed specular: but among crystallized minerals, we have specular iron, from the brilliancy of its planes. *Speculum*, in Latin, signifies a looking-glass.

*Specular and Splintery Fracture* belong to imperfectly crystalline minerals. The fractures do not greatly differ: they are both irregular; the specular is shorter and more pointed than the splintery.

*Stalactiform, (Stalagma,)* in the Greek, signifies a drop, an icicle. Stalactiform minerals greatly resemble icicles in shape.

*Stalagmite.* A stalagmite is the deposition afforded by the water dropping from a stalactite, as on the floor of a cavern.

*Stellated.* When the crystals or fibres of a mineral diverge all round a common centre, it is said to be stellated: *stella*, in Latin, signifies a star.

*Strie, Striated.* The slight channels occasionally observable on the planes of crystallized minerals are termed strie, and the crystals on which they are seen are said to be striated. The strie are commonly parallel, and generally indicate the direction in which crystals may be cleaved. *Stria*, in Latin, signifies a groove, or channel.

*Sulphate.* A mineral in which the sulphuric acid is combined with a base, as *lime*, in the sulphate of lime.

*Sulphuret.* A metallic mineral in which the metal is combined with sulphur. In these minerals, the metal is not in the state of an oxide, but in the metallic state.

*Tabular.* When this term is used in relation to structure, it is nearly allied to the schistose or slaty. Talc, mica, and roofing slate, are described by the German School, as possessing a tabular structure. This term is used more generally to express the external form of such crystals as are nearly flat: these are termed tabular crystals; from the Latin, tabula, a table board.

*Toughness* relates to internal texture. Those minerals which are bruised, or suffer depression by repeated blows, in the attempt to fracture them, are esteemed to be tough.

*Translucent.* A mineral through which an object cannot be seen, but which transmits some light, is termed translucent. Rock salt, sometimes quartz, flint, and fluor, &c. are translucent: many minerals are translucent on the edges, as common marble, &c.

*Transparent.* Those minerals are transparent through which an object may be clearly seen.

*Tubercular.* A mineral whose unevenness of surface arises from small and somewhat round elevations, is said to be tubercular. Flint is sometimes tubercular.

*Tuberous*; exhibiting somewhat circular knobs, or elevations.

*Unctuous.* The term relates to the touch. Pipe-clay is somewhat unctuous: fuller's earth is unctuous; plumbago and soapstone are very unctuous.—*Phillip's Mineralogy.*

*Vesicular.* A mineral is said to be vesicular, when it has small and somewhat round cavities, both internally and externally. Lava, pumice, limestone, basalt, &c. are sometimes vesicular; from the Latin, vesicula, a little bladder.

*Vitreous*; from the Latin vitreus, glassy; minerals having the lustre of glass are said to possess the vitreous lustre.

## A TABLE,

*Exhibiting the angular admeasurements of crystals by the Reflecting Goniometer, according to Phillips.*

- Actynolite.* Rhombic prism,  $124^{\circ} 30'$  and  $55^{\circ} 30'$  alternately.
- Adularia.* In one direction, four of  $90^{\circ}$ ; in another, four, alternately of  $59^{\circ} 25'$  and  $120^{\circ} 33'$ ; and in another, four, alternately of  $67^{\circ} 15'$  and  $112^{\circ} 45'$ . These are obtained with great difficulty.
- Albite.* In one direction, alternately  $93^{\circ} 30'$  and  $86^{\circ} 30'$ ; in another,  $119^{\circ} 30'$  and  $60^{\circ} 30'$ ; and in another direction,  $115^{\circ}$  and  $65^{\circ}$ .
- Amblygonite.* Rhombic prism,  $106^{\circ} 10'$  and  $73^{\circ} 50'$  alternately. (See carbonate of zinc.)
- Amethyst.* Primitive rhomboid,  $94^{\circ} 15'$  and  $85^{\circ} 45'$  alternately. (See quartz.)
- Analcime.* Primitive cube,  $90^{\circ}$ , and  $90^{\circ}$  in all directions.
- Andalusite.* Rhombic prism,  $88^{\circ} 40'$  and  $91^{\circ} 20'$  alternately.
- Anthophyllite.* Rhombic prism,  $125^{\circ}$  and  $55^{\circ}$  alternately.
- Arfvedsonite.* Rhombic prism,  $123^{\circ} 55'$  on one of the lateral planes. (Hornblende,  $124^{\circ} 30'$ .)
- Araggonite.* Rhombic prism  $116^{\circ} 5'$  and  $63^{\circ} 55'$  alternately.
- Arsenate of copper.* Rhomboidal,  $110^{\circ} 30'$  and  $69^{\circ} 30'$  alternately.
- Arsenate of copper.* Oblique prismatic,  $124^{\circ}$  and  $56^{\circ}$  alternately.
- Arsenate of copper.* Right prismatic,  $110^{\circ} 5'$  and  $69^{\circ} 10'$ .
- Arsenate of copper.* Martial. Primitive rhomb  $120^{\circ}$  and  $60^{\circ}$ .
- Arsenic.* Sulphuret of. Rhombic prism, lateral planes,  $74^{\circ} 15'$  and  $105^{\circ} 45'$  alternately.
- Arsenical iron.* Lateral planes,  $111^{\circ} 12'$  and  $69^{\circ} 48'$  alternately.
- Augite.* Primitive rhomb,  $87^{\circ} 5'$  and  $92^{\circ} 55'$  alternately. (See specular iron, and Bourmonite.)
- Barytes, sulphate of.* Primary prism, from fractured surfaces,  $101^{\circ} 42'$  and  $78^{\circ} 18'$  alternately.
- Bismuth, Sulphuret of.* After cleavage in one direction,  $90^{\circ}$ , with indications of cleavage, parallel to  $130^{\circ}$  and  $50^{\circ}$ .
- Calc-spar.* Primitive rhomb,  $106^{\circ} 15'$  and  $73^{\circ} 45'$ . Also, in some specimens,  $105^{\circ} 20'$  and  $72^{\circ} 40'$ , alternately. (See calcareous spar, and cyanite.)
- Borate of lime.* Primitive rhomb,  $103^{\circ} 40'$  and  $76^{\circ} 20'$ , alternately.
- Borate of soda.* Primitive rhomb,  $86^{\circ} 36'$  and  $93^{\circ} 30'$ , alternately.
- Bourmonite.* Primitive  $90^{\circ}$  and  $90^{\circ}$ , or a rhomb of  $93^{\circ} 30'$  and  $86^{\circ} 30'$ , alternately. (See specular iron, augite, and borate of lime.)
- Calc-spar.* Cleavage parallel to the planes of a rhomb of  $100^{\circ}$  and  $80^{\circ}$ .
- Calcareous spar.* Primary, obtuse rhomboid of  $105^{\circ} 5'$ , and  $74^{\circ} 55'$ , alternately. (See bitters obtained. (See bitter spar.)
- Chalcocite of iron.* Cleavage parallel to planes of  $106^{\circ} 30'$  and  $73^{\circ} 30'$  alternately.

## TABLE OF ANGLES.

- Carbonate of iron.* Cleavage, parallel to the planes of  $107^{\circ}$  and  $73^{\circ}$ .  
*Carbonate of lead.* Primary, right rhombic prism of  $117^{\circ}$  and  $63^{\circ}$ .  
*Carbonate of magnesia, and iron.* Primitive  $107^{\circ} 30'$  and  $72^{\circ} 30'$ . (See spar.)  
*Carbonate of strontian.* Primitive, right rhombic prism of  $117^{\circ} 32'$  and  $62^{\circ} 28'$  alternately. (See carbonate of lead.)  
*Celestine.* Primitive, right rhombic prism of  $104^{\circ}$  and  $76^{\circ}$ . (See calcareous spar.)  
*Chabaise.* Obtuse rhomboid,  $94^{\circ} 46'$  and  $86^{\circ} 14'$  alternately.  
*Chromate of iron.* Octohedron, two adjacent planes, give an angle of  $109^{\circ} 28'$ . (See arseniate of iron.)  
*Chromate of lead.* Oblique prism, of  $93^{\circ} 30'$  add  $96^{\circ} 30'$ . (See chabaise.)  
*Chrysolite.* Primitive, a cube.  
*Cinnabar.* Acute rhomboid, of  $71^{\circ} 48'$  and  $108^{\circ} 12'$ .  
*Cobalt, arsenical.* Primary, a cube.  
*Copper, sulphuret of.* Double six-sided pyramid, the incidence of an upper, on the adjacent plane of the lower pyramid, being about  $147^{\circ} 30'$ .  
*Copper, muriate of.* Primitive, a right rhombic prism, of  $100^{\circ}$  and  $80^{\circ}$ .  
*Copper, phosphate of.* Right rhombic prism  $110^{\circ}$  and  $70^{\circ}$ .  
*Corundum.* Primary, rhomboid, of  $86^{\circ} 4'$  and  $93^{\circ} 56'$ .  
*Cyanite.* Primary, a doubly oblique prism, of  $106^{\circ} 15'$  and  $73^{\circ} 45'$  of the terminal plane on the prism, in one direction,  $100^{\circ} 50'$  and  $79^{\circ} 10'$ , and in another  $93^{\circ} 15'$  and  $86^{\circ} 45'$  alternately. (See chabaise, Sillimanite, Cleavelandite, and bitter spar.)  
*Diopside.* Primary, oblique rhombic prism, of  $87^{\circ} 5'$  and  $92^{\circ} 55'$  alternately.  
*Egeran.* Angles of cleavage,  $90^{\circ}$ .  
*Epidote.* Primary, right oblique angled prism of  $115^{\circ} 30'$ , and  $64^{\circ} 30'$ . (See arragonite.)  
*Eudyalite.* Lateral planes,  $120^{\circ}$ . Summit, with the lateral planes,  $90^{\circ}$ .  
*Felspar.* See adularia.  
*Fibrolite.* Right prism, with rhombic bases, of  $100^{\circ}$  and  $80^{\circ}$ .  
*Fettersstein.* Cleaves parallel to all the planes and diagonals of a right rhombic prism, of  $112^{\circ}$ , and  $68^{\circ}$ .  
*Fucite.* Cleaves parallel to the lateral planes of a rhombic prism, of  $87^{\circ}$  and  $93^{\circ}$ .  
*Galena.* Primary, the cube.  
*Gehlenite.* Primary, the cube.  
*Glauberite.* Primary, rhombic prism, lateral planes,  $83^{\circ} 20'$  and  $96^{\circ} 40'$ . Terminal, and lateral planes,  $104^{\circ} 15'$  and  $75^{\circ} 45'$ , alternately.  
*Hedenburgite.* Cleavage, parallel to the sides of a rhombic prism, of  $124^{\circ} 30'$  and  $55^{\circ} 30'$ , alternately.  
*Hornblende.* Cleavage, parallel to the sides, of  $124^{\circ} 30'$ , and  $55^{\circ} 30'$ , alternately. (See actynolite, and Arfwedsonite.)  
*Humite.* Right rhombic prism, of  $120^{\circ}$  and  $60^{\circ}$  alternately.  
*Hypersthene.* Rhombic prism, sides,  $87^{\circ}$  and  $93^{\circ}$  alternately.  
*Idocrase.* Right prism with square bases, of  $90^{\circ}$  and  $90^{\circ}$ .  
*Indianite.* Cleaves into prisms of  $95^{\circ} 15'$  and  $84^{\circ} 45'$  alternately, (see glaucoberite, quartz, and tabular spar.)  
*Iron, arsenical.* Cleaves parallel to  $111^{\circ} 12'$  and  $68^{\circ} 48'$  alternately.  
*Iron pyrites.* Primary, a cube, to all the parallel planes of which it cleaves.  
*Iron pyrites, white.* Primary, a right rhombic prism of  $106^{\circ}$  and  $73^{\circ}$ . Cleavage parallel to all its planes. (See cyanite and carbonate of iron.)  
*Iron, specular oxide of.* Primitive acute rhomboid of  $86^{\circ} 10'$  and  $93^{\circ} 50'$ . (See augite, Bourmonite, and Sillimanite.)  
*Iron, carbonate of.* Cleavage parallel to all the planes of an obtuse rhomboid of  $107^{\circ}$  and  $73^{\circ}$ . (See iron pyrites, Sillimanite, and cyanite.)  
*Jenite.* Primary, a rhomboid of  $111^{\circ} 30'$  and  $68^{\circ} 30'$ . (See arseniate of copper.)



*Killinite.* Cleavage parallel to the planes of a rhombic prism of  $135^{\circ}$  and  $45^{\circ}$ .

*Latrobeite.* Cleavage in three directions parallel to all the planes of a doubly oblique prism, viz. in one direction  $98^{\circ} 30'$  and  $81^{\circ} 30'$ , in another  $91^{\circ}$  and  $89^{\circ}$ , and in the third  $93^{\circ} 30'$  and  $86^{\circ} 30'$ . (See specular iron, and hypersthene.)

*Laumontite.* Oblique rhombic prism; inclination of lateral planes  $113^{\circ} 30'$ ; inclination of terminal, with the lateral planes  $86^{\circ} 15'$ .

*Lead, sulphato-carbonate of.* Primary, oblique prism of  $120^{\circ} 45'$  and  $59^{\circ} 15'$ .

*Lead, sulphato-tri-carbonate of.* Primary, an acute rhomboid of  $72^{\circ} 30'$  and  $107^{\circ} 30'$ . (See carbonate of iron.)

*Lead, cupreous sulphato-carbonate of.* Primary, a right rhombic prism of  $95^{\circ}$  and  $85^{\circ}$ .

*Lead, sulphate of.* Primary, a right rhombic prism of  $103^{\circ} 42'$  and  $76^{\circ} 18'$ .

*Lead, molybdate of.* Cleavage parallel to an octohedron with a square base; angle of two opposite terminal planes  $49^{\circ} 45'$ ; of the upper and lower terminal planes  $130^{\circ} 15'$ .

*Ligurite.* Oblique rhombic prism of  $140^{\circ}$  and  $40^{\circ}$  alternately.

*Manganese, grey oxide of.* Cleaves parallel to the planes of a rhombic prism of  $100^{\circ}$  and  $80^{\circ}$ .

*Mica.* Primary, oblique rhombic prism of  $120^{\circ}$  and  $60^{\circ}$ .

*Muriate of soda.* Primary, a cube.

*Orpiment.* Primary, a right rhombic prism of  $100^{\circ}$  and  $80^{\circ}$ .

*Pargasite.* Cleavage parallel to the lateral planes of a rhombic prism of  $124^{\circ} 30'$  and  $55^{\circ} 30'$ , being the same with actinolite and hornblende.

*Polyhalite.* Cleavage, parallel to all the planes of the cube, affording brilliant faces of  $90^{\circ}$  in every direction.

*Prehnite.* Primary  $100^{\circ}$  and  $80^{\circ}$ .

*Pyroxene.* See augite.

*Quartz.* Primary rhomboid  $94^{\circ} 15'$  and  $85^{\circ} 45'$ .

*Realgar.* Cleaves parallel to all the planes of an oblique rhombic prism, whose lateral planes are  $74^{\circ} 15'$  and  $105^{\circ} 45'$  alternately.

*Rhomb spar.* See bitter spar.

*Ruby.* Oriental, primary, acute rhomboid of  $93^{\circ} 56'$  and  $86^{\circ} 4'$ .

*Sahlite.* Primary rhomb  $92^{\circ} 55'$  and  $87^{\circ} 5'$ ; the same as augite.

*Sapphire.* The same as ruby.

*Selenite.* Primary, a right oblique angled prism, of which the bases are oblique angled parallelograms of  $113^{\circ} 8'$  and  $66^{\circ} 52'$ .

*Silver.* Flexible sulphuret of. Oblique angled prism of  $125^{\circ}$  and  $55^{\circ}$  alternately, on the lateral planes.

*Silver, red.* Primary, obtuse rhomboid, of  $108^{\circ} 30'$  and  $71^{\circ} 30'$ .

*Sphene.* Primary, an oblique rhombic prism, lateral angles  $133^{\circ} 30'$  and  $46^{\circ} 30'$ , alternately.

*Spinellane.* Primary, the rhombic dodecahedron, of  $90^{\circ}$  and  $120^{\circ}$ .

*Spodumene.* Cleavage parallel to the planes and shorter diagonal of a rhombic prism of  $100^{\circ}$  and  $80^{\circ}$ ; the same as Prehnite.

*Staurotide.* Primary, a right rhombic prism of  $129^{\circ} 20'$  and  $50^{\circ} 40'$ .

*Sulphate of strontian.* See celestine.

*Sulphuret of antimony.* Primary, right rhombic prism of  $88^{\circ} 30'$  and  $91^{\circ} 30'$  alternately.

*Tabular spar.* Cleaves into prisms of  $95^{\circ} 20'$  and  $84^{\circ} 40'$  alternately. (See cupreous sulphuret of lead, indianite, and quartz.)

*Thomsonite.* Cleaves parallel to the lateral planes of  $90^{\circ}$ .

*Tin, oxide of.* Primary, an obtuse octohedron with a square base, the angle over the apex being  $112^{\circ} 10'$  and a plane of one pyramid, on the adjoining plane of the other,  $67^{\circ} 50'$ .

*Tungstate of lime.* The angle formed by the meeting of a plane of the upper, with the adjoining plane of the lower pyramid  $128^{\circ} 40'$ .

*Topaz.* Primary, a right rhombic prism of  $124^{\circ} 22'$  and  $55^{\circ} 38'$  alternately.

*Tourmaline.* Primary, an obtuse rhomboid of  $133^{\circ} 30'$  and  $46^{\circ} 10'$  alternately.

*Wavellite.* Cleavage parallel to both sides of a prism of  $122^{\circ} 15'$  and  $57^{\circ} 45'$ .

*Yenite.* See *Jenite*.

*Zinc.* Red oxide of. Cleaves parallel to the planes of a six-sided prism, each lateral plane on the adjoining one being  $120^{\circ}$  and the terminal on the lateral plane  $90^{\circ}$ .

*Zinc.* Silicious oxide of. Primary, a right rhombic prism of  $102^{\circ} 30'$  and  $77^{\circ} 30'$  alternately.

*Zinc.* Carbonate of. Cleavage parallel to all the planes of a rhomboid of about  $106^{\circ} 30'$  and  $73^{\circ} 30'$ . (See *amblygonite*, *bitter spar*, and *carburet of iron*.)

*Zircon.* Primary, an obtuse octohedron of  $95^{\circ} 40'$  and  $84^{\circ} 20'$ . (See *glauberite*, *indianite*, *quartz*, &c.)

*Zoisite.* Cleaves parallel to the sides of a rhombic prism of  $120^{\circ}$  and  $60^{\circ}$ .

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